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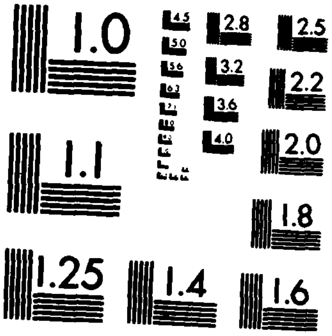
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# DOCUMENTATION OF ELEVEN PROGRAMS FOR THE HEWLETT-PACKARD 97 CALCULATOR

W. M. PUGH

REPORT NO. 79-10

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# DOCUMENTATION OF ELEVEN PROGRAMS
# FOR THE HEWLETT-PACKARD 97 CALCULATOR*

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# Documentation of Eleven Programs
# for the Hewlett-Packard 97 Calculator

by

William M. Pugh

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San Diego, California 92152

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# INTRODUCTION

# Introduction

This report contains documentation on eleven separate programs developed for the Hewlett-Packard HP-97 programmable calculator. Nine of these programs are statistical routines that differ from most of the available programs which are designed to receive raw data values as input. Instead, the input for the routines contained in this report is summary information commonly printed out when statistical analyses are performed on large computer systems.

By accepting such intermediate data as input, these routines offer several advantages to the researcher. First, it allows him to operate in an "interactive mode" with the data. For example, one can try several combinations of variables in a regression equation and observe how the beta weights "behave" as variables are added and deleted. Second, the results are immediately available and can be obtained at any time and wherever the researcher may be. Finally, there is the money saved by reducing the number of analyses run on large computer systems.

The documentation of each program includes the type of analyses performed, the input required, and options available. Also, any program limits or special procedures for preparing the data are specified. A step by step set of instructions is provided together with test data and the output that results when the program is properly executed. Finally, the relevant formulas and a program listing are included with each program.

At the end of this report is an index which lists the various tests performed by these programs and the coefficients computed. The index was provided because many of the programs generate several statistical indices.

Before operating these programs it is strongly recommended that the user read the first four sections (through p. 75) of the HP-97 Owner's Handbook and Programming Guide. Among the topics discussed in these sections are: the use of the switches on the calculator, how to use a prerecorded program, how to control the display, how to enter negative numbers, and how to perform calculations from the keyboard. A brief outline of the procedures to run the programs in this report are as follows:

a) The Pgrm-Run switch should be set on Run,
b) The Man-Trace-Norm switch should be set on Man,
c) Turn the Off-On switch to On,
d) Insert program card into the machine,
e) If the display reads Crd, insert the other side of the card into the machine,
f) Follow the step by step instructions provided in the program documentation.

In addition, the user should be aware that to enter negative numbers one should enter the numerical digits first then press the CHS key to change the sign. Also, to display and print out more (or fewer) digits, press the DSP and then a number corresponding to the number of digits to be displayed. Again, the user is urged to read the Owner's Handbook for a complete discussion of these and other procedures.

# STATISTICAL

# PROGRAMS

# Chi Square Computation

## Program Summary

This program computes the chi square value from the cell and column totals of a bivariate frequency matrix. The method of computation was described by McNemar (1969, p. 267).

## Instructions for Running Program

### Program limits:

The number of rows in the frequency matrix must not exceed ten. There is no limit on the number of columns.

### Data preparation:

Before this program can be executed, the cell frequencies must be summed within each column to produce column totals. It is not necessary to compute row totals, however.

### Program execution:

Step

1 Enter program.

2 Press E.

3 Enter column total and press A.

4 Enter each of the cell frequencies in the column, pressing B after each cell value.

* Repeat Steps 3 and 4 for each column. That is: Enter a column total, press A. Then enter each cell frequency in that column, pressing B after each cell value until all the data is entered.

5 After all the data has been entered, press C to compute the chi square value ($\chi^2$). Note: The degrees of freedom for the chi square is the number of rows minus one multiplied by the number of columns minus one (i.e., df = [R-1],[C-1].).

* To compute a new chi square, go to Step 2.

## Test Data

| | | Column | | |
|---|---|---|---|---|
| | | I | II | III |
| Row | I | 50 | 30 | 20 |
| | II | 60 | 70 | 40 |
| | III | 10 | 20 | 30 |
| Column Totals | | 120 | 120 | 90 |

Program results:

$\chi^2 = 28.09$

Formula:

$$\chi^2 = \left(\sum_{i=1}^{R} \sum_{j=1}^{C} f_{ij}\right) \left\{ \sum_{k=1}^{R} \left[ \sum_{j=1}^{C} \left(f^2_{kj}/\left(\sum_{i=1}^{R} f_{ij}\right)\right)/\left(\sum_{j=1}^{C} f_{kj}\right)\right]-1\right\}$$

(See McNemar, 1969; p. 267).

Program Listing:

```
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
006  [illegible]  [illegible] 12
007  [illegible]  [illegible] 12
008  R[illegible]         24
009  *LBL[illegible]  21 11
010  STO[illegible]   35 11
011  RCLE        36 12
012     +          -55
013  STOE        35 12
014     0           00
015  STOI        35 46
016   RTN           24
017  *LBLE       21 12
018  ST+i     35-55 45
019    X²           53
020   P⇄S        16-51
021  RCLA        36 11
022     ÷          -24
023  ST+i     35-55 45
024   P⇄S        16-51
025  ISZI     16 26 46
026  RCLI        36 46
027   RTN           24
028  *LBLC       21 13
029  DSZI     16 25 4[illegible]
030  GTO0        22 0[illegible]
031  GTO1        22 0[illegible]
032  *LBL0       21 0[illegible]
033  GSBD        23 14
034  GTOC        22 13
035  *LBL1       21 01
036  GSBD        23 14
037  RCLC        36 13
038     1           01
039     -          -45
040  RCLE        36 12
041     x          -35
042  STO7        35 07
043   RTN           24
044  *LBLD       21 14
045   P⇄S        16-51
046  RCLi        36 45
047   P⇄S        16-51
048  RCLi        36 45
049     ÷          -24
050  RCLC        36 13
051     +          -55
052  STOC        35 13
053   RTN           24
054  *LBL[illegible]  21 16 11
055     1           01
056  STO3        35 03
[illegible]
[illegible]
[illegible]
[illegible]

[illegible]
[illegible]
[illegible]
064  GTO[illegible]   22 [illegible]
065     1           0[illegible]
066     -          -4[illegible]
067    N!        16 52
068  STO3        35 03
069  GTO5        22 05
070  *LBL2       21 02
071     .          -62
072     5           05
073  X=Y?        16-33
074  GTO3        22 03
075   X⇄Y          -41
076     1           01
077     -          -45
078  STx3     35-35 03
079  GTO2        22 02
080  *LBL3       21 03
081    Pi        16-24
082    √X           54
083  RCL3        36 03
084     x          -35
085  STO3        35 03
086  *LBL5       21 05
087  RCL7        36 07
088  STO2        35 [illegible]
089  RCL1        36 [illegible]
090     1      [illegible]
091     -          -[illegible]
092    Yˣ           3[illegible]
093  RCL2        36 02
094     2           02
095     ÷          -24
096   CHS          -22
097    eˣ           33
098     x          -35
099     2           02
100  RCL1        36 01
101    Yˣ           31
102     ÷          -24
103  RCL3        36 03
104     ÷          -24
105  STO5        35 05
106  RCL7        36 07
107  RCL2        36 02
108  RCL1        36 01
109     ÷          -24
110  STx5     35-35 05
111     2           02
112  RCL1        36 01
113     x          -35
114  STO6        35 06
115     1           01
116  STO4        35 04
117  *LBL4       21 04
[illegible]      36 02
[illegible]      35 06
[illegible]         02

12[illegible]               -55
12[illegible]            35 06
12[illegible]               -24
124  RCL4        36 04
125  [illegible]           -35
126  STO4        35 04
127     +          -[illegible]
128  X≠Y?        16-[illegible]
129  GTO4        22 [illegible]
130  RCL5        36 [illegible]
131     x      [illegible]
132     1           01
133   X⇄Y          -41
134     -          -45
135   RTN           24
136   R/S           51
```

## t-Tests for the Difference between Means

### Program Summary

This program will compute the t value between uncorrelated means or between correlated means. The t-test between uncorrelated means requires input of the N, mean, and standard deviation of measures for both groups. The t-test between correlated means can be computed using either the N, mean, and standard deviation of the measures for each group and the correlation between the measures, or, the mean and standard deviation of the difference between each pair of measures.

### Instructions for Running Program

Data preparation:

Standard deviations should be computed as sample estimates of the population value. Thus, standard deviations should be computed as follows:

$$S = [\Sigma (x-\bar{x})^2 / (N-1)]^{1/2}.$$

Note, the denominator is (N-1) rather than N.

Program execution:

Enter program. If measures are uncorrelated, follow procedure for Case I. If measures are correlated, follow procedure for Case II.

Case I (t-test for uncorrelated measures):

Step

1 Press E.

2 Enter mean for group 1 ($\bar{x}_1$), press A*.

3 Enter standard deviation for group 1 ($S_1$), press A.

4 Enter frequency for group 1 ($N_1$), press A.

5 Enter $\bar{X}_2$, press A.

6 Enter $S_2$, press A.

7 Enter $N_2$, press A.

8 Press B, and the t value with $N_1+N_2-2$ degrees of freedom is displayed.

Case II (t-test for correlated measures):

Procedure A. This procedure uses the N, mean, and standard deviation of each group and the correlation between the measures of the two groups.

Step

1 Press E.

2 Enter mean for group 1 ($\bar{x}_1$), press A*.

3 Enter standard deviation for group 1 ($S_1$), press A.

4 Enter frequency for group 1 ($N_1$), press A.

5 Enter $\bar{x}_2$, press A.

6 Enter $S_2$, press A.

7 Enter the correlation between the measures ($r_{12}$), press C, and the t value with $N_1$-1 degrees of freedom is displayed. Note: The degrees of freedom is the number of pairs minus one.

Procedure B. This procedure uses input based on the differences between data pairs. The N is the number of pairs. The mean and standard deviations are computed on the difference scores.

Step

1 Press E.

2 Enter the mean of the difference scores ($M_D$), press A*.

3 Enter the standard deviation of the difference scores, press A.

4 Enter the number of pairs of data points (N), press A.

5 Press D, and the t value with N-1 degrees of freedom is displayed.

*If an incorrect value has been entered and A has been pressed, press fA and then enter the correct value. If more than one value needs correction, press fA for each step you wish to back up.

## Test Data

Data set 1:

Raw Data

| | Group 1 | Group 2 | Difference Scores |
|---|---|---|---|
| | 1 | 1 | 0 |
| | 1 | 2 | -1 |
| | 1 | 3 | -2 |
| | 1 | 4 | -3 |
| | 2 | 1 | 1 |
| | 2 | 2 | 0 |
| | 2 | 3 | -1 |
| | 2 | 4 | -2 |
| $\bar{x}$ | 1.500 | 2.500 | -1.000 |
| S | .535 | 1.195 | 1.309 |
| N | 8 | 8 | 8 |

$r_{12} = 0.0$

Program results:

Case I: $t = 2.160$
Case II: Procedure A, $t = 2.160$
Procedure B, $t = 2.161$

Data set 2:

Raw Data

| | Group 1 | Group 2 | Difference Scores |
|---|---|---|---|
| | 1 | 1 | 0 |
| | 1 | 2 | -1 |
| | 2 | 3 | -1 |
| | 2 | 4 | -2 |
| | 3 | 5 | -2 |
| | 3 | 6 | -3 |
| $\bar{x}$ | 2.000 | 3.500 | -1.500 |
| S | .894 | 1.871 | 1.049 |
| N | 6 | 6 | 6 |

$r_{12} = .956$

Program results:

Case I: $t = 1.772$
Case II: Procedure A, $t = 3.501$
Procedure B, $t = 3.503$

## Formulae

Case I:

$$t=(\bar{x}_1-\bar{x}_2)/[\{[(N_1-1)S_1^2+(N_2-1)S_2^2]/[N_1+N_2-2]\}\{(N_1+N_2)/(N_1N_2)\}]^{1/2}$$

Case II:

Procedure A

$$t=[(\bar{x}_1-\bar{x}_2)N_1^{1/2}]/(S_1^2+S_2^2-2r_{12}S_1S_2)^{1/2}$$

Procedure B

$$t=(\bar{x}_{(1-2)}\sqrt{N_{(1-2)}})\ /\ S_{(1-2)}$$

Note: The above formuli are equivalent to those found in Hays (1963) on pages 320 and 335. However, in the present equation, S is the sample estimate of the standard deviation rather than the population value.

## Program Listing:

```
[illegible]   STOI     35 46
[illegible]   RTN         24
[illegible]  *LBLA     21 11
[illegible]   DSZI  16 25 46
007   STOI     35 45
008    RTN        24
009  *LBLE     21 15
010   RCL1     36 01
011   RCL4     36 04
012      -       -45
013   RCL3     36 03
014      1        01
015      -       -45
016   RCL2     36 02
017     X²        53
018      x       -35
019   RCL6     36 06
020      1        01
021      -       -45
022   RCL5     36 05
023     X²        53
024      x       -35
025      +       -55
026   RCL3     36 03
027   RCL6     36 06
028      +       -55
029      2        02
030      -       -45
031      ÷       -24
032   RCL3     36 03
033   RCL6     36 06
034      +       -55
035      x       -35
036   RCL3     36 03
037   RCL6     36 06
038      x       -35
039      ÷       -24
040     √X        54
041      ÷       -24
042    RTN        24
043  *LBLC     21
044   STO7     35
045   RCL1     36
046   RCL4     36
047      -       -
048   RCL3     36
049     √X
050      x       -35
051   RCL2     36 02
052     X²        53
053   RCL5     36 05
054     X²        53
055      +       -55
056      2        02
057  [illegible] 36 07
```

```
                   36 05
                     -35
                     -45
064                   54
065      ÷           -24
066    RTN            24
067  *LBLD         21 14
068   RCL1         36 01
069   RCL3         36 0
070     √X
071      x           -
072   RCL2         36
073      ÷           -2
074    RTN            2
075  *LBLa      21 16 11
076   RCLI         36 46
077      1            01
078      -           -45
079   STOI         35 46
080    RTN            24
081    R/S            51
```

# One-way ANOVA

## Program Summary

Given the N, mean, and standard deviation of two or more groups, this program computes the grand N, mean, and standard deviation. In addition, it computes the percentage of the total variance that occurs between groups ($\underline{R}^2$) and $\underline{F}$-ratio for the between-group versus within-group variance (i.e., performs a one-way ANOVA).

## Instructions for Running Program

### Data preparation:

The group standard deviations should be computed as sample estimates of the population values. Thus, group standard deviations should be computed as follows:

$$S = [\Sigma\ (x-\bar{x})^2/(N-1)]^{1/2}$$

### Program execution:

Step

1 Enter program.

2 Press E.

3 If only the grand N and mean are to be computed, press fa.

4 If output is to be printed, press fb.

5 Enter data. If fa was pressed, enter group N, press ↑; enter group mean, press A.

If fa was not pressed, enter group N, press ↑; enter group mean, press ↑; enter group standard deviation, press A.

* Repeat Step 5 for each group until the data for each group have been entered.

6 Press B to compute the grand N.

7 Press C to compute the grand mean.

8 Press D to compute the grand standard deviation. Note: D must be pressed before either the $R^2$ or the $\underline{F}$-ratio can be computed.

9 Press fc to compute $R^2$ (the correlation ratio or the percentage of the total variance that occurs between groups).

10 Press fd to compute the $\underline{F}$-ratio for comparing the between-group and within-group variance.

11 Press fe to display the degrees of freedom for the above $\underline{F}$-ratio. First, the between-group degrees of freedom is shown, then after a pause, the degrees of freedom for the residual is shown.

## Test Data

### Raw Data

| | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| | 3 | 4 | 9 |
| | 2 | 3 | 8 |
| | 7 | 1 | 6 |
| | | 2 | |
| | | 1 | |
| $\bar{x}$ | 4.000 | 2.200 | 7.667 |
| S | 2.646 | 1.304 | 1.528 |
| N | 3 | 5 | 3 |

**Program results:**

$N_T = 11$

$\bar{X}_T = 4.182$

$S_T = 2.857$

$R^2 = .688$

$F = 8.821$

$df = 2$ & $8$

## Formulae

$$N_T = \sum_{j=1}^{G} n_j$$

where G = the number of groups

$$\bar{X}_T = \sum_{j=1}^{G} (n_j \bar{x}_j)/N$$

$$S_T = [SS_T/(N-1)]^{1/2}$$

$$\text{where } SS_T = \sum_{j=1}^{G} S_j^2 (n_j-1) + \sum_{j=1}^{G} n_j \bar{x}_j^2 - (\sum_{j=1}^{G} n_j \bar{x}_j)^2/N$$

$$R^2 = [SS_T - \sum_{j=1}^{G} S_j^2 (n_j-1)]/SS_T$$

$$F = \{[SS_T - \sum_{j=1}^{G} S_j^{\,2}\ (n_j-1)]/(G-1)\}/\{[\sum_{j=1}^{G} S_j^{\,2}\ (n_j-1)]/(N-G)\}$$

degrees of freedom:

between = G-1

residual = N-G

Note: see McNemar, 1969, Chapter 15 for ANOVA rationale.

Program Listing:

```
[illegible]
[illegible]
005     [illegible]        -51
006     [illegible]        [illegible]
007    *LBL[illegible]     21 [illegible]
008     [illegible]   16 26 4[illegible]
009     [illegible]   16 [illegible]
010    GTO[illegible]      22 0[illegible]
011    STO7        35 07
012      R↓          -31
013   *LBL[illegible]      21 0[illegible]
014    STO6        35 06
015      R↓          -31
016    STO5        35 05
017    ST+1     35-55 01
018    RCL6        36 06
019       ×          -35
020    ST+2     35-55 02
021     F0?     16 23 00
022    GTO1        22 01
023    RCL5        36 05
024    RCL6        36 06
025      X²           53
026       ×          -35
027    ST+3     35-55 03
028    RCL7        36 07
029      X²           53
030    RCL5        36 05
031       1           01
032       -          -45
033       ×          -35
034    ST+4     35-55 04
035   *LBL1        21 01
036    RCLI        36 46
037     RTN           24
038   *LBLB        21 12
039    RCL1        36 01
040     F1?     16 23 01
041    PRTX          -14
042     RTN           24
043   *LBLC        21 13
044    RCL2        36 02
045    RCL1        36 01
046       ÷          -24
047     F1?     16 23 01
048    PRTX          -14
049     RTN           24
050   *LBLD        21 14
051    RCL4        36 04
052    RCL3        36 03
053       +          -55
054    RCL2        36 02
055      X²           53
056    RCL1        36 01
057     [illegible]        -24
058     [illegible]        [illegible]
059     [illegible]        [illegible]
060     [illegible]        [illegible]
```

```
[illegible]                  -45
063       ÷          -24
064       √           54
065     F1?     16 23 01
066    PRTX          -14
067     RTN           24
068   *LBLa     21 16 11
069     SF0     16 21 00
070     RTN           24
071   *LBLb     21 16 12
072     SF1     16 21 01
073     RTN           24
074   *LBLc     21 16 13
075    RCL8        36 08
076    RCL4        36 04
077       -          -45
078    RCL8        36 08
079       ÷          -24
080     F1?     16 23 01
081    PRTX          -14
082     RTN           24
083   *LBLd     21 16 14
084    RCL8        36 08
085    RCL4        36 04
086       -          -45
087    RCLI        36 46
088       1           01
089       -          -45
090       ÷          -24
091    RCL4        36 04
092    RCL1        36 01
093    RCLI        36 46
094       -          -45
095       ÷          -24
096       ÷          -24
097     F1?     16 23 01
098    PRTX          -14
099     RTN           24
100   *LBLe     21 16 15
101    RCLI        36 46
102       1           01
103       -          -45
104     PSE        16 51
105     F1?     16 23 01
106    PRTX          -14
107    RCL1        36 01
108    RCLI        36 46
109       -          -45
110     F1?     16 23 01
111    PRTX          -14
112     RTN           24
113     R/S           51
```

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# Multiple Regression

## Program Summary

Given the intercorrelation among a set of variables, the program will compute the multiple correlation of 2 to 6 predictor (independent) variables with a criterion (dependent) variable. Further, it will compute the standardized regression weight (beta weight) for each predictor variable. In addition, if the mean value and standard deviation is available for each variable, this program will compute the regression weights and constant for the raw variable scores. The computation methods are based upon the square root method developed by Summerfield and Lubin (1951) and Lubin and Summerfield (1951).

## Instructions for Running Program

### Program limits:

A maximum of six predictors can be used in a single equation.

### Data preparation:

Let P = predictor, C = criterion, M = mean, and S = standard deviation. Set up the data to be analyzed in the following manner:

| | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ | $P_6$ | | |
|---|---|---|---|---|---|---|---|---|
| $P_1$ | | | | | | | $M_1$ | $S_1$ |
| $P_2$ | $r_{21}$ | | | | | | $M_2$ | $S_2$ |
| $P_3$ | $r_{31}$ | $r_{32}$ | | | | | $M_3$ | $S_3$ |
| $P_4$ | $r_{41}$ | $r_{42}$ | $r_{43}$ | | | | $M_4$ | $S_4$ |
| $P_5$ | $r_{51}$ | $r_{52}$ | $r_{53}$ | $r_{54}$ | | | $M_5$ | $S_5$ |
| $P_6$ | $r_{61}$ | $r_{62}$ | $r_{63}$ | $r_{64}$ | $r_{65}$ | | $M_6$ | $S_6$ |
| C | $r_{C1}$ | $r_{C2}$ | $r_{C3}$ | $r_{C4}$ | $r_{C5}$ | $r_{C6}$ | $M_C$ | $S_C$ |

### Program execution:

Section I

Step

1 Enter card 1 (MR1).

2 Press E.

Step

3 Press A, then enter intercorrelations among predictors by row, pressing R/S after each value. That is, after pressing A, enter the $r_{21}$ value, press R/S, enter the $r_{31}$ value, press R/S, enter the $r_{32}$ value, press R/S, etc., until all the correlations among the predictors are entered.

* If the same set of predictors is used to predict multiple criteria, press f write data and enter a blank card. Then for each successive criterion enter card 1 (MR1), enter the data card, and then execute the program from Step 4 (i.e., press B).

4 Press B, enter the correlations between the predictor and the criterion, pressing R/S after each value. That is, after pressing B, enter $r_{C1}$, press R/S, enter $r_{C2}$, press R/S, etc., until each predictor-criterion correlation has been entered.

5 Press C.

* If there are 3 or more predictors, proceed to Section II. Execute Steps 6 through 12 only if there are 2 predictors.

6 Press fa; the multiple correlation will be printed.

7 Press fb; the beta weights for $P_1$ and then $P_2$ will be printed.

8 If variable means and standard deviations are available and regression weights are desired, press fc, and execute remaining steps.

9 Enter $M_C$, press enter ↑.

10 Enter $S_C$, press R/S.

11 Enter the means and standard deviations for the respective predictors in the same manner (i.e., $M_1$, ↑, $S_1$, R/S, $M_2$, ↑, $S_2$, R/S).

* After the mean and standard deviation for each predictor is entered, the regression weight is printed. Note: The value displayed in the X register is not the regression weight.

12 After the regression weights are printed, press fd and the regression constant will be printed.

## Section II

Step

1 After executing steps 1 through 5 of Section I, enter card 2 (MR2).

2 Press A and the multiple correlation will be printed.

## Section III

### Step

1 Enter card 3 (MR3).

* Option A: If card 2 (MR2) has just been executed, Press A and the beta weight for each predictor will be printed.[a]

* Option B: If beta weights are already available and regression weights are desired, Press B. Then enter the beta weight for each predictor, pressing R/S after each value. That is, enter $\beta_1$ and press R/S, enter $\beta_2$, press R/S, etc.

2 If regression weights are desired and either option A or B has been executed, Press C.

3 Enter $M_C$ and press ↑.

4 Enter $S_C$ and press R/S.

5 Enter the means and standard deviations for the respective predictors in the same manner (i.e., $M_1$, ↑, $S_1$, R/S, $M_2$, ↑, $S_2$, R/S, etc.).

* After the mean and standard deviation for each predictor is entered, the regression weight is printed. Note: The value displayed in the X register is not the regression weight.

6 After the regression weights are printed, press D and the regression constant will be printed.

### Test Data

| | $P_1$ | $P_2$ | $P_3$ | $P_4$ | M | S |
|---|---|---|---|---|---|---|
| $P_1$ | | | | | 14.27 | 3.14 |
| $P_2$ | .04 | | | | 3.14 | 1.24 |
| $P_3$ | .17 | .01 | | | 2.17 | 2.11 |
| $P_4$ | .06 | .11 | .09 | | .89 | .57 |
| C | .23 | .34 | .27 | .41 | 5.22 | 1.48 |

---

[a] Before computing beta weights, consider inspecting the following registers: primary register 6, secondary registers 0 and 5, and registers C and I. These registers represent the tolerance values for predictor variables 2, 3, 4, 5 and 6, respectively. It is suggested that a variable with a tolerance of less than .05 be deleted from the analysis since that variable is virtually linearly dependent with one or more of the preceeding variables. If one of these values reaches zero, it is entirely linearly dependent and its beta weight cannot be computed (i.e., Error will be displayed if one attempts to compute the beta weight via Option A).

Program results:

Multiple Correlation = .580

| Predictor | Beta Weights | Regression Weights |
|---|---|---|
| $P_1$ | $\beta_1 = .162$ | $B_1 = .076$ |
| $P_2$ | $\beta_2 = .293$ | $B_2 = .350$ |
| $P_3$ | $\beta_3 = .208$ | $B_3 = .146$ |
| $P_4$ | $\beta_4 = .349$ | $B_4 = .907$ |
| | | Constant =1.909 |

Formulae

The computations in this program are based upon the square root method developed by Summerfield and Lubin (1951) and Lubin and Summerfield (1951). The correspondence between the HP-97 storage registers and a data matrix of 6 predictors and 1 criterion by 6 predictors is as follows:

| | | Predictors | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Predictors | 1 | | | | | | |
| | 2 | $R_0$ | $R_6$ | | | | |
| | 3 | $R_1$ | $R_7$ | $R_{S0}$ | | | |
| | 4 | $R_2$ | $R_8$ | $R_{S1}$ | $R_{S5}$ | | |
| | 5 | $R_3$ | $R_9$ | $R_{S2}$ | $R_{S6}$ | $R_C$ | |
| | 6 | $R_4$ | $R_A$ | $R_{S3}$ | $R_{S7}$ | $R_D$ | $R_I$ |
| Criterion | 7 | $R_5$ | $R_B$ | $R_{S4}$ | $R_{S8}$ | $R_E$ | $R_{S9}$ |

where $R_0$ - $R_9$ = primary registers and $R_{S0}$ - $R_{S9}$ = secondary registers, the values contained in these registers are as follows:

| Storage Registers | | | |
|---|---|---|---|
| $R_0$ | $r_{12}$ | | |
| $R_1$ | $r_{13}$ | | |
| $R_2$ | $r_{14}$ | | |
| $R_3$ | $r_{15}$ | | |
| $R_4$ | $r_{16}$ | | |
| $R_5$ | $r_{17}$ | | |
| $R_6$ | -- | $r_{2(2.1)} = \sqrt{1-r_{12}^2}$ | |
| $R_7$ | $r_{23}$ | $r_{3(2.1)} = \dfrac{r_{23}-r_{12}r_{13}}{\sqrt{1-r_{12}^2}}$ | |
| $R_8$ | $r_{24}$ | $r_{4(2.1)} = \dfrac{r_{24}-r_{12}r_{14}}{\sqrt{1-r_{12}^2}}$ | |
| $R_9$ | $r_{25}$ | $r_{5(2.1)} = \dfrac{r_{25}-r_{12}r_{15}}{\sqrt{1-r_{12}^2}}$ | |
| $R_A$ | $r_{26}$ | $r_{6(2.1)} = \dfrac{r_{26}-r_{12}r_{16}}{\sqrt{1-r_{12}^2}}$ | $B_1 = r_{17}-B_2r_{12}-B_3r_{13}-B_4r_{14}-B_5r_{15}-B_6r_{16}$ |
| $R_B$ | $r_{27}$ | $r_{7(2.1)} = \dfrac{r_{27}-r_{12}r_{17}}{\sqrt{1-r_{12}^2}}$ | $B_2 = (r_{7(2.1)}-B_3r_{3(2.1)}-B_4r_{4(2.1)}-B_5r_{5(2.1)}-B_6r_{6(2.1)})/r_{2(2.1)}$ |
| $R_{S0}$ | -- | $r_{3(3.1,\ 2)} = \sqrt{1-r_{13}^2-r_{3(2.1)}^2}$ | |
| $R_{S1}$ | $r_{34}$ | $r_{4(3.1,\ 2)} = (r_{34}-r_{13}r_{14}-r_{3(2.1)}r_{4(2.1)}) \,/\, r_{3(3.1,\ 2)}$ | |
| $R_{S2}$ | $r_{35}$ | $r_{5(3.1,\ 2)} = (r_{35}-r_{13}r_{15}-r_{3(2.1)}r_{5(2.1)}) \,/\, r_{3(3.1,\ 2)}$ | |
| $R_{S3}$ | $r_{36}$ | $r_{6(3.1,\ 2)} = (r_{36}-r_{13}r_{16}-r_{3(2.1)}\ r_{6(2.1)}) \,/\, r_{3(3.1,\ 2)}$ | |

Storage
Registers

$R_{S4}$ $r_{37}$ $r_{7(3.1,\ 2)} = (r_{37}-r_{13}r_{17}-r_{3(2.1)}r_{7(2.1)}) \,/\, r_{3(3.1,\ 2)}$

$R_{S5}$ -- $r_{4(4.1,\ 2,\ 3)} = \sqrt{1-r_{14}{}^{2}-r_{4(2.1)}{}^{2}-r_{4(3.1,\ 2)}{}^{2}}$

$R_{S6}$ $r_{45}$ $r_{5(4.1,\ 2,\ 3)} = (r_{45}-r_{14}r_{15}-r_{4(2.1)}r_{5(2.1)}-r_{4(3.1,\ 2)}$
$r_{5(3.1,\ 2)}) \,/\, r_{4(4.1,\ 2,\ 3)}$

$R_{S7}$ $r_{46}$ $r_{6(4.1,\ 2,\ 3)} = (r_{46}-r_{14}r_{16}-r_{4(2.1)}r_{6(2.1)}-r_{4(3.1,\ 2)}$
$r_{6(3.1,\ 2)}) \,/\, r_{4(4.1,\ 2,\ 3)}$

$R_{S8}$ $r_{47}$ $r_{7(4.1,\ 2,\ 3)} = (r_{47}-r_{14}r_{17}-r_{4(2.1)}r_{7(2.1)}-r_{4(3.1,\ 2)}$
$r_{7(3.1,\ 2)}) \,/\, r_{4(4.1,\ 2,\ 3)}$

$R_{S9}$ $*r_{67}$ $r_{7(6.1,\ 2,\ 3,\ 4,\ 5)} = (r_{67}-r_{16}r_{17}-r_{6(2.1)}r_{7(2.1)}-r_{6(3.1,\ 2)}$
$r_{7(3.1,\ 2)}-r_{6(4.1,\ 2,\ 3)}r_{7(4.1,\ 2,\ 3)}$
$-r_{6(5.1,\ 2,\ 3,\ 4)}r_{7(5.1,\ 2,\ 3,\ 4)} \,/$
$r_{6(6.1,\ 2,\ 3,\ 4,\ 5)}$

$R_C$ -- $r_{5(5.1,\ 2,\ 3,\ 4)} = \sqrt{1-r_{15}{}^{2}-r_{5(2.1)}{}^{2}-r_{5(3.1,\ 2)}{}^{2}-r_{5(4.1,\ 2,\ 3)}{}^{2}}$

$B_3 = (r_{7(3.1,\ 2)}-B_4r_{4(3.1,\ 2)}-B_5r_{5(3.1,\ 2)}-B_6r_{6(3.1,\ 2)}) \,/$
$r_{3(3.1,\ 2)}$

$R_D$ $r_{56}$ $r_{6(5.1,\ 2,\ 3,\ 4)} = (r_{56}-r_{15}r_{16}-r_{5(2.1)}r_{6(2.1)}-r_{5(3.1,\ 2)}$
$r_{6(3.1,\ 2)}-r_{5(4.1,\ 2,\ 3)}r_{6(4.1,\ 2,\ 3)}) \,/$
$r_{5(5.1,\ 2,\ 3,\ 4)}$

$B_4 = (r_{7(4.1,\ 2,\ 3)}-B_5r_{5(4.1,\ 2,\ 3)}-B_6r_{6(4.1,\ 2,\ 3)}) \,/$
$r_{4(4.1,\ 2,\ 3)}$

Storage
Registers

$R_E$ $r_{57}$

$$r_{7(5.1,\ 2,\ 3,\ 4)} = (r_{57}-r_{15}r_{17}-r_{5(2.1)}r_{7(2.1)}-r_{5(3.1,\ 2)}r_{7(3.1,\ 2)}-r_{5(4.1,\ 2,\ 3)}r_{7(4.1,\ 2,\ 3)}) \,/\, r_{5(5.1,\ 2,\ 3,\ 4)}$$

$$B_5 = \frac{(r_{7(5.1,\ 2,\ 3,\ 4)}-B_6 r_{6(5.1,\ 2,\ 3,\ 4)})}{r_{5(5.1,\ 2,\ 3,\ 4)}}$$

$R_I$ --

$$r_{6(6.1,\ 2,\ 3,\ 4,\ 5)} = \sqrt{1-r_{16}^2-r_{6(2.1)}^2-r_{6(3.1,\ 2)}^2-r_{6(4.1,\ 2,\ 3)}^2-r_{6(5.1,\ 2,\ 3,\ 4)}^2}$$

$$B_6 = \frac{r_{7(6.1,\ 2,\ 3,\ 4,\ 5)}}{r_{6(6.1,\ 2,\ 3,\ 4,\ 5)}}$$

Multiple R

$$R = \sqrt{1-(1-r_{17}^2-r_{7(2.1)}^2-r_{7(3.1,\ 2)}^2-r_{7(4.1,\ 2,\ 3)}^2-r_{7(5.1,\ 2,\ 3,\ 4)}^2 -r_{7(6.1,\ 2,\ 3,\ 4,\ 5)}^2}$$

Note: *** $y' = B_1 \frac{S_c}{S_1} X_1 + B_2 \frac{S_c}{S_2} X_2 + B_3 \frac{S_c}{S_3} X_3 + B_4 \frac{S_c}{S_4} X_4 + B_5 \frac{S_c}{S_5} X_5 + B_6 \frac{S_c}{S_6} X_6 + (M_c - B_1 \frac{S_c}{S_1} M_1 - B_2 \frac{S_c}{S_2} M_2 - B_3 \frac{S_c}{S_3} M_3 - B_4 \frac{S_c}{S_4} M_4 - B_5 \frac{S_c}{S_5} M_5 - B_6 \frac{S_c}{S_6} M_6)$

Program Listing:

```
001  *LBL[illegible]
002  CLR[illegible]
003   P⇄S      16-[illegible]
004  CLRG      16-[illegible]
005   [illegible]
006   RTN          24
007  *LBLC     21 [illegible]
008  RCL0      36 0[illegible]
009  GSB2      23 02
010  RCL6      36 06
011     ÷         -24
012   RTN          24
013  *LBL2     21 02
014     x         -35
015     -         -45
016   RTN          24
017  *LBLA     21 11
018   R/S          51
019  STO0      35 00
020   R/S          51
021  STO1      35 01
022   R/S          51
023  STO7      35 07
024   R/S          51
025  STO2      35 02
026   R/S          51
027  STO8      35 08
028   R/S          51
029   P⇄S      16-51
030  STO1      35 01
031   P⇄S      16-51
032   R/S          51
033  STO3      35 03
034   R/S          51
035  STO9      35 09
036   R/S          51
037   P⇄S      16-51
038  STO2      35 02
039   R/S          51
040  STO8      35 08
041   P⇄S      16-51
042   R/S          51
043  STO4      35 04
044   R/S          51
045  STOA      35 11
046   R/S          51
047   P⇄S      16-51
048  STO3      35 03
049   R/S          51
050  STO7      35 07
051   P⇄S      16-51
052   R/S          51
053  STO[illegible]  35 14
054   RTN          24
[illegible]        21 12
[illegible]            51
[illegible]        35 [illegible]
[illegible]            51
[illegible]        35 12
0[illegible]           51

[illegible]            51
[illegible]        16-51
[illegible]        35 [illegible]
[illegible]        16-51
[illegible]            51
[illegible]
[illegible]            51
[illegible]        16-51
[illegible]        35 03
[illegible]        16-51
[illegible]
[illegible]        21 [illegible]
[illegible]            01
077  RCL0      36 00
078   [illegible]      55
079     -         -45
080   [illegible]      54
081   [illegible]  35 08
082  RCL7      36 07
083  RCL1      36 01
084  GSB0      23 00
085  STO7      35 07
086  RCL8      36 08
087  RCL2      36 02
088  GSB0      23 00
089  STO8      35 08
090  RCL5      36 05
091  RCL3      36 03
092  GSB0      23 00
093  STO5      35 05
094  RCLA      36 11
095  RCL4      36 04
096  GSB0      23 00
097  STOA      35 11
098  RCLB      36 12
099  RCL5      36 05
100  GSB0      23 00
101  STOB      35 12
102   RTN          24
103  *LBL[illegible]  21 16 11
104  RCL5      36 05
105   [illegible]      55
106  RCLB      36 12
107   [illegible]      55
[illegible]           -55
[illegible]            54
[illegible]           -14
[illegible]            24
[illegible]     21 16 12
[illegible]        36 12
[illegible]        36 06
[illegible]           -24
[illegible]        35 12
[illegible]        36 0[illegible]
[illegible]        36 12
[illegible]
[illegible]

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]           -51
[illegible]        35 [illegible]
[illegible]            51
[illegible]        36 [illegible]
131   [illegible]     -31
132  STO0      35 00
133  RCL1      36 01
134  RCLA      36 11
135     x         -35
136  STO2      35 02
137  RCL1      36 01
138  RCLB      36 12
139     x         -35
140  STO3      35 03
141   CLX         -51
142   R/S          51
143  RCL2      36 02
144   X⇄Y         -41
145     ÷         -24
146  STO2      35 02
147  PRTX         -14
148     x         -35
149  ST-0   35-45 00
150   R/S          51
151  RCL3      36 03
152   X⇄Y         -41
153     ÷         -24
154  STO3      35 03
155  PRTX         -14
156     x         -35
157  ST-0   35-45 00
158   RTN          24
159  *LBLc  21 16 13
160  RCL0      36 00
161  PRT[illegible]      -14
162   RTN          24
163   R/S          51
```

```
[illegible]
[illegible]
[illegible]
004   [illegible]   -7
005   *LBLB   21 12
006   [illegible]   -35
007   -      -45
008   [illegible]   -24
009   *LBLA   21 11
010      1      01
011   RCL1   36 01
012   GSB1   23 01
013   RCL7   36 07
014   GSB1   23 01
015     √x      54
016    P⇄S   16-51
017   STO0   36 00
018   RCL1   36 01
019    P⇄S   16-51
020   RCL1   36 01
021   RCL2   36 02
022   GSB2   23 02
023   RCL7   36 07
024   RCL8   36 08
025   GSB2       2
026    P⇄S
027   RCL0       3
028      ÷
029   STO1   35 01
030   RCL2   36 02
031    P⇄S   16-51
032   RCL1   36 01
033   RCL3   36 03
034   GSB2   23 02
035   RCL7   36 07
036   RCL9   36 09
037   GSB2   23 02
038    P⇄S   16-51
039   RCL0   36 00
040      ÷     -24
041   STO2   35 02
042   RCL3   36 03
043    P⇄S   16-51
044   RCL1   36 01
045   RCL4   36 04
046   GSB2   23 02
047   RCL7   36 07
048   RCLA   36 11
049   GSB2   23 02
050    P⇄S   16-51
051   RCL0   36 00
052      ÷     -24
053   STO3   35 03
054   RCL4   36 04
055    P⇄S   16-51
056   RCL1   36 01
057   [illegible]   36 [illegible]
058          23 02
059          36 07
060          36 12

               2 32
              16-51
              36 00
064      ÷     -24
065   STO4   35 04
066    P⇄S   16-51
067      1      01
068   RCL2   36 02
069   GSB1   23 01
070   RCL8   36 08
071   GSB1   23 01
072    P⇄S   16-51
073   RCL1   36 01
074   GSB1   23 01
075     √x      54
076   STO5   35 05
077   RCL6   36 06
078    P⇄S   16-51
079   RCL2   36 02
080   RCL3   36 03
081   GSB2   23 02
082   RCL8   36 08
083   RCL9   36 09
084   GSB2   23 02
085    P⇄S   16-51
086   RCL1   36 01
087   RCL2   36 02
088   GSB2   23 02
089   RCL5   36 05
090      ÷
091   STO6
092   RCL7
093    P⇄S
094   RCL2
095   RCL4   36 04
096   GSB2   23 02
097   RCL8   36 08
098   RCLA   36 11
099   GSB2   23 02
100    P⇄S   16-51
101   RCL1   36 01
102   RCL3   36 03
103   GSB2   23 02
104   RCL5   36 05
105      ÷     -24
106   STO7   35 07
107   RCL8   36 08
108    P⇄S   16-51
109   RCL2   36 02
110   RCL5   36 05
111   GSB2   23 02
112   RCL8   36 08
113   RCLB   36 12
114   GSB2   23 02
115    P⇄S   16-51
116   RCL1   36 01
117      -   36 0[illegible]
118      1   23 02
119          36 05
120            -24

[illegible]
[illegible]
[illegible]
124   GSB1   23 01
125   RCL6   36 06
126   GSB1   23 01
127    P⇄S   16-51
128   RCL3   36 03
129   GSB1   23 01
130   RCL9   36 09
131   GSB1   23 01
132     √x      54
133   STOC   35 13
134   RCLD   36 14
135   RCL3   36 03
136   RCL4   36 04
137   GSB2   23 02
138   RCL5   36 05
139   RCLA   36 11
140   GSB2   23 02
141    P⇄S   16-51
142   RCL2   [illegible]
143   RCL3   [illegible]
144   GSB2   [illegible]
145   RCL6   [illegible]
146   RCL7   [illegible]
147   GSB2   23 02
148   RCLC   36 13
149      ÷     -24
150   STOD   35 14
151   RCLE   36 15
152   RCL2   36 02
153   RCL4   36 04
154   GSB2   23 02
155   RCL6   36 06
156   RCL8   36 08
157   GSB2   23 02
158    P⇄S   16-51
159   RCL3   36 03
160   RCL5   36 05
161   GSB2   23 02
162   RCL9   36 09
163   RCLB   36 12
164   GSB2   23 02
165   RCLC   36 13
166      ÷     -24
167   STOE   35 15
168      1      01
169   RCL4   36 04
170   GSB1   23 01
171   RCLA   36 11
172   GSB1   23 01
173    P⇄S   16-51
174   RCL3   36 03
175   GSB1   23 01
176   RCL7   36 07
177          23 01
178          36 14
179          23 01
180             54

              35 46
              36 09
              36 07
              36 04
              23 02
              36 07
              36 02
              23 02
              36 14
              36 15
              23 02
[illegible]   16-51
193   RCL4   36 04
194   RCL5   36 05
195   GSB2   23 02
196   RCLA   36 11
197   RCLB   36 12
198   GSB2   23 02
199   RCL[illegible]   36 46
200      ÷     -24
201    P⇄S   16-51
202   STO9   35 09
203      1      01
204   RCL4   36 04
205   GSB1   23 01
206   RCL8   36 08
207   GSB1   23 01
208   RCLE   36 15
209   GSB1   23 01
210   RCL9   36 09
211   GSB1   23 01
212    P⇄S   16-51
213      -   36 05
214   GSB1   23 01
215   RCLB   36 12
216   GSB1   23 01
217             01
218            -41
219            -45
220             54
221            -14
222             24
223             51
```

```
004   [illegible]
005   *LBLA     21 11
006    P⇄S      16-51
007   RCL2      36 02
008   RCLI      36 46
009     ÷         -24
010   STOI      35 46
011   RCLE      36 15
012   RCLI      36 46
013   RCLD      36 14
014   GSB2      23 02
015   RCLC      36 13
016     ÷         -24
017   STOE      35 15
018   RCL6      36 06
019   RCLE      36 15
020   RCL6      36 06
021   GSB2      23 02
022   RCLI      36 46
023   RCL7      36 07
024   GSB2      23 02
025   RCL5      36 05
026     ÷         -24
027   STOD      35 14
028   RCL4      36 04
029   RCLD      36 14
030   RCL1      36 01
031   GSB2      23 02
032   RCLE      36 15
033   RCL2      36 02
034   GSB2      23 02
035   RCLI      36 46
036   RCL3      36 03
037   GSB2      23 02
038   RCL8      36 08
039     ÷         -24
040   STOC      35 13
041    P⇄S      16-51
042   RCLB      36 12
043   RCLC      36 13
044   RCL7      36 07
045   GSB2      23 02
046   RCLD      36 14
047   RCL8      36 08
048   GSB2      23 02
049   RCLE      36 15
050   RCL5      36 05
051   GSB2      23 02
052   RCLI      36 46
053   RCLA      36 11
054   GSB2      23 02
055   [illegible]

064   GSB2      23 02
065   RCLD      36 14
066   RCL2      36 02
067   GSB2      23 02
068   RCLE      36 15
069   RCL3      36 03
070   GSB2      23 02
071   RCLI      36 46
072   RCL4      36 04
073   GSB2      23 02
074   STOA      35 11
075   PRTX        -14
076   RCLB      36 12
077   PRTX        -14
078   RCLC      36 13
079   PRTX        -14
080   RCLD      36 14
081   PRTX        -14
082   RCLE      36 15
083   PRTX        -14
084   RCLI      36 46
085   PRTX        -14
086    RTN         24
087   *LBLB     21 12
088    R/S         51
089   STOA      35 11
090    R/S         51
091   STOB      35 12
092    R/S         51
093   STOC      35 13
094    R/S         51
095   STOD      35 14
096    R/S         51
097   STOE      35 15
098    R/S         51
099   STOI      35 46
100    RTN         24
101   *LBLC     21 13
102    CLX        -51
103   STO0      35 00
104   STO1      35 01
105   STO2      35 02
106    P⇄S      16-51
107   STO9      35 09
108   [illegible]
109    R/S         51
110   STO1      35 01
111    R↓         -31
112   STO0      35 00
113   RCLA      36 11
114   GSB1      23 01
115   [illegible]
116   [illegible]

123   [illegible]

139    RTN
140   *LBL[illegible]  21
141   RCL[illegible]   36
142   PRT[illegible]
143    RTN         24
144   *LBL3     21 03
145    R/S         51
146   ISZI    16 26 46
147   ST÷I    35-24 45
148    X⇄Y        -41
149   RCLI      36 45
150   PRTX        -14
151     ×         -35
152   ST-0    35-45 00
153    RTN         24
154   *LBL1     21 01
155   RCL1      36 01
156     ×         -35
157    RTN         24
158                51
```

# Scheffé t-test

## Program Summary

After an ANOVA has been run on a data set and it has been determined that there is a significant difference among the group means, the Scheffé *t*-test can be used to identify which means are significantly different from each other. To make these post hoc comparisons, the user first enters the N, mean, and standard deviation of each group in the original ANOVA. Then the comparisons desired are selected and *t*-tests are performed. Significant differences are indicated by a flashing display. The computational procedures are based upon those described by McNemar (1969, pp. 323-324), and Hays (1963, pp. 485-487).

## Instructions for Running Program

There can be a maximum of eight groups in the design.

## Data Preparation:

The standard deviations should be estimates of the population value, i.e., $S = [\Sigma (x-\bar{x})^2 / (N-1)]^{1/2}$.

## Program execution:

Step

1 Enter program.

2 Press E.

3 Enter data set for group i.

* Enter $n_i$, press ↑.

* Enter $\bar{x}_i$, press ↑.

* Enter $S_i$, press A. Where $n_i$ is the number of people in the $i^{th}$ group, $\bar{x}_i$ is the mean and $S_i$ the standard deviation.

* Repeat Step 3 for each group in the original ANOVA.

4 For the desired level of confidence (e.g., $p < .05$), look up the critical *F* value with (G-1) and (N-G) degrees of freedom, where N is the total number of people in the original ANOVA and G is the total number of groups. Enter this *F* value and press B.

5 Decide which groups are to be contrasted. The *t* value to be computed will reflect the difference between the mean values of the sets of groups contrasted. That is, each group in a contrast should be designated as being within set 1 or set 2 and then the test will be performed between the respective mean values.

Step

* To designate groups, press C and a group number will be displayed (i.e., group 1). Then press:
0 if group 1 is not to be used in the contrast
1 if group 1 is to be designated as being in set 1
2 if group 1 is to be designated as being in set 2.

* Press R/S and the number of the next group will be displayed. Press 0, 1, or 2 to designate the data set the group is in and press R/S.

* Repeat until the data for all groups to be designated as being in set 1 or 2 have been entered.

6 To compute the t value, press D. If this value is significant at the confidence level selected in Step 4 it will flash on and off; otherwise it will just stay on.

* For the t to be significant it must be equal to or greater than K, where: $K = [(G-1)\, F_{(G-1),\ (N-G)}]^{1/2}$.
K can be retrieved by pressing RCL D.

7 To compute other contrasts on the same set of data, go to Step 4.

Test Data

| | Group | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| n: | 10 | 12 | 15 | 13 | 15 |
| $\bar{x}$: | 3.42 | 5.73 | 3.27 | 5.83 | 5.61 |
| S: | 1.21 | 1.34 | 1.17 | 1.44 | 1.48 |

Desired level of confidence: $p \leq .05$.

Program results:

Since the overall F-ratio for the above data is significant [$F = 12.29$, $p < .01$], it is legitimate to compute post hoc comparisons by the Scheffé method. Of the numerous contrasts that could be performed, 3 were selected for the purposes of illustration: 1) group 1 versus group 2, 2) group 1 versus group 3, and 3) group 1 and 3 versus groups 2, 4, and 5. Note: because the desired level of confidence is .05, the proper F value to use at Step 4 in each of the comparisons is 2.53. Test results:

| Comparison | t value |
|---|---|
| Group 1 versus group 2 | -4.03 |
| Group 1 versus group 3 | .27 |
| Groups 1 and 3 versus groups 2, 4, and 5 | -6.99 |

## Formulae

The contrast difference (i.e., the mean difference being tested) is:

$$D' = [(\Sigma n_i \bar{x}_i) / \Sigma n_i] - [(\Sigma n_j \bar{x}_j) / \Sigma n_j]$$

where $n_i$ and $\bar{x}_i$ are the number of people and the mean score for groups in set I and $n_j$ and $\bar{x}_j$ are the corresponding values for groups in set II.

The error variance for the above contrast is:

$$S_{D'}^2 = S_W^2 (1 / \Sigma n_i + 1 / \Sigma n_j)$$

where $S_W^2 = [\sum_g^G S_g^2 (n_g - 1) / (N-G)]$

where G is the total number of groups and N is the total number of people (i.e., $\Sigma n_g$).

The t value is computed as follows: $t = D' / S_{D'}$

If this t value is equal to or greater than K, then it is considered significant. The K value is:

$$K = [(G-1) F_{(G-1),\ (N-G)}]^{1/2}$$

where $F_{(G-1),\ (N-G)}$ is the F value for the desired level of significance with G-1 and N-G degrees of freedom.

**Program Listing:**

```
013  [illegible]            073  ST+0      [illegible]
014  [illegible]            074  -         [illegible]
015  [illegible]            075  ST÷9      [illegible]
016  [illegible]            076  P⇄S       16-51
017  [illegible]            077  GTO2      22 [illegible]
018  1         01           078  *LBL3     21 [illegible]
019  -         [illegible]  079  RCLA      36 11
020  RCLD      [illegible]  080  RCLB      36 12
021            -35          081  RCLC      36 13
022  RCL[illegible]         082  -         -45
023  [illegible] -35        083  ÷         -24
024  STO[illegible] 35 [illegible]  084  STO[illegible]
025  1         01           085  R[illegible]
026  RCLE      36 15        086  RCL[illegible]
027  -         -45          087  [illegible]
028  STOE      35 15        088  P⇄S       16-51
029  RCL6      36 06        089  RCL9      36 [illegible]
030  STOB      35 12        090  RCL6      36 06
031  RCLI      36 46        091  ÷         -24
032  RTN       24           092  -         [illegible]
033  *LBLE     21 15        093  RCL[illegible]
034  RCLE      36 15        094  [illegible]
035  1         01           095  [illegible]
036  -         -45          096  RCLC      36 13
037  x         -35          097  [illegible]  02
038  √x        54           098  +         -55
039  STOD      35 14        099  RCLC      36 1[illegible]
040  [illegible] [illegible]  100  x         -35
041  STO[illegible]         101  √x        [illegible]
042  STO[illegible]         102  ÷         [illegible]
043  P⇄S       16-51        103  STO[illegible]
044  STO[illegible]         104  [illegible]
045  STO[illegible]         105  [illegible]
046  P⇄S       16-51        106  [illegible]
047  STO[illegible]         107  [illegible]
048  RTN       24           108  [illegible]
049  *LBL[illegible]        109  [illegible]
050  [illegible]            110  [illegible]
051  [illegible]            111  [illegible]
052  [illegible]            112  *LBL4
053  [illegible]            113  [illegible]
054  [illegible]            114  [illegible]
```

[illegible]

# Alpha

## Program Summary

Given the intercorrelations and standard deviations of a set of items, this program will compute Cronbach's coefficient alpha (Lord & Novick, 1968; pp. 88-89). In addition, the program can compute the correlation between a weighted or unweighted composite formed from the item set and another item. Finally, it is possible to use this program to compute the correlation between two composites from the item correlations and standard deviations.

## Instructions for Running Program

### Program limits:

A maximum of 18 items can be within an item set.

### Data preparation:

Standard deviations are assumed to be sample estimates of the population parameters, i.e., $S = [(x-\bar{x})^2 / (N-1)]^{1/2}$.

1) To compute alpha or to form an unweighted composite, set up the input data as follows:

$$\begin{array}{llcccccccc}
 & & \multicolumn{7}{c}{\text{Item}} \\
 & & 1 & 2 & 3 & \cdot & \cdot & \cdot & K \\
 & 1 & & & & & & & \\
 & 2 & r_{21} & & & & & & \\
 & 3 & r_{31} & r_{32} & & & & & \\
\text{Item} & \cdot & \cdot & \cdot & & & & & \\
 & \cdot & \cdot & \cdot & & & & & \\
 & \cdot & \cdot & \cdot & & & & & \\
 & K & r_{K1} & r_{K2} & r_{K3} & & & & \\
\text{Standard Deviations} & & S_1{}^* & S_2 & S_3 & \cdot & \cdot & \cdot & S_K
\end{array}$$

*If an item is to be reversed, make its standard deviation negative (i.e., -S).

2) To form a weighted composite (e.g., to apply validation sample regression weights to a cross-validation sample), set up the item intercorrelations as above. However, substitute U for each S where U = SW and W is the item weight.

3) To correlate two composite scores, set up the data as described above and compute alpha values for the two item sets separately and for all the items as a single set. After each pass (i.e., once an alpha is computed), recall the values in the A and C registers by pressing RCL A and RCL C. Call these values for set I, $A_I$ and $C_I$; for set II, $A_{II}$ and $C_{II}$; for the combination $A_{I+II}$ and $C_{I + II}$.

Program execution:

Step

1 Enter program.

2 Press E.

3 If computing alpha or forming an unweighted composite, enter item standard deviations, pressing A after each value (i.e., enter $S_1$, press A, enter $S_2$, press A, etc).

* If forming a weighted composite, enter the U values in place of S values, pressing A after each value.

4 Enter the item correlations for the lower triangle of the correlation matrix by row pressing B after each value (i.e., enter $r_{21}$, press B, enter $r_{31}$, press B, enter $r_{32}$, press B, etc).

5 Press fa.

* If alpha is being computed, the value displayed is the alpha coefficient.

* If computing the correlation between composites, recall registers A and C.

6 To find the correlation between the composite of the above items and another item (y), press fb.

* Then enter the correlation between each item in the composite and y, pressing R/S after each value (i.e., press fb, enter $r_{1y}$, press R/S, enter $r_{2y}$, press R/S, etc.).

* After entering the final correlation, press fc and the item-composite correlation ($r_{cy}$) will be displayed.

* To compute the correlation of the above composite with a new item, repeat Step 6.

7 To compute the correlation between two composites, press fd.

* Enter $A_I$, press enter ↑,
Enter $C_I$, press R/S,

Enter $A_{II}$, press enter ↑,
Enter $C_{II}$, press R/S,

Enter $A_{I+II}$, press enter ↑,
Enter $C_{I+II}$, press R/S.

* Press fe and $r_{I, II}$ will be printed followed by $r_{I, (I+II)}$.

Step

* To compute $r_{II,(I+II)}$, repeat Step 7 entering $A_{II}$ in place of $A_I$, $C_{II}$ in place of $C_I$, and vice versa.

Test Data

Correlations:

| | | Items | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Set I | 1 | | | | | |
| | 2 | .2234 | | | | |
| | 3 | .3465 | .2945 | | | |
| Set II | 4 | .4500 | .2866 | .5530 | | |
| | 5 | .1570 | .1221 | .2366 | .2006 | |
| Standard Deviations | | .9118 | .9680 | 1.0425 | .9123 | 1.1160 |
| Item Correlations with y | | -.2390 | -.3397 | -.3714 | -.3667 | -.2456 |
| Item Weights (w) | | -.1012 | -.2479 | -.2578 | | |
| U Values (SW) | | -.0923 | -.2400 | -.2688 | | |

Program results:

1) Alpha coefficients for items in Set I, Set II, Set I and II combined, and the contents of registers A and C:

| | | Contents of Register | |
|---|---|---|---|
| | Alpha | A | C |
| Item Set I | .5488 | 2.8552 | .8237 |
| Item Set II | .3286 | 2.0777 | .2042 |
| All Items | .6588 | 4.9330 | 2.7483 |

2) Correlations of item sets with y:

a) unweighted composites: $r_{IY} = -.4401$

$r_{IIY} = -.3860$

$r_{(I+II)Y} = -.4777$

b) weighted composite (Set I only): $r_{I'Y} = .4510$

where I´ is the weighted composite of items in Set I.

3) Correlations between composites:

$$r_{I,II} = .5142$$
$$r_{I,\ (I+II)} = .9081$$
$$r_{II,\ (I+II)} = .8261$$

## Formulae

The formuli in this program are based on those presented by Lord and Novick (1968; p. 84-97).

1) Alpha:

$$\alpha = [K/(K-1)]\ [1-(\Sigma S_i^{\,2} / S_X^{\,2})]$$

where K is the number of items, $S_i$ are the item standard deviations, X is the item composite (i.e., $X = x_1' + x_2' + \ldots x_K'$).

Thus, $S_X^{\,2} = \Sigma S_i^{\,2} + 2\underset{ij}{\Sigma\Sigma}\ S_i\ S_j\ r_{ij}$ where $i<j$

2) Composite correlations with y ($r_{XY}$):

$$r_{Xy} = \frac{C_{Xy}}{S_X\ S_y}$$

where $C_{Xy} = \frac{1}{N}\ \Sigma\ (X-\bar{X})\ (y-\bar{y})$

$$= \frac{1}{N}\ \Sigma\ [(x_1'-\bar{x}_1') + (x_2' - \bar{x}_2')\ \ldots\ ]\ (y-\bar{y})$$

$$= C_{x_1'y} + C_{x_2'y}\ \ldots$$

so, $C_{Xy} = S_y\ \underset{i}{\Sigma}\ r_{iy}\ S_i$

$$\text{thus, } r_{Xy} = \frac{S_y\ \underset{i}{\Sigma}\ r_{iy}\ S_i}{S_X\ S_y} = \frac{\underset{i}{\Sigma}\ r_{iy}\ S_i}{S_X}$$

3) Correlation between composites:

Let $A = \Sigma\ S_i^{\,2}$

and $C = \underset{i}{\Sigma}\ \underset{j}{\Sigma}\ S_i\ S_j\ r_{ij}$ where $i < j$

then $S_X^{\,2} = A + 2C$

and, $S_I{}^2 = A_I + 2C_I$

$$S_{II}{}^2 = A_{II} + 2C_{II}$$

$$S^2{}_{(I+II)} = A_{(I+II)} + 2C_{(I+II)}$$

a) $$r_{I,\ II} = \frac{C_{I,\ II}}{S_I\ S_{II}}$$

and since $S^2_{(I+II)} = S^2{}_I + S_{II}^{\ 2} + 2C_{I,\ II}$

$$r_{I,II} = \frac{[S^2{}_{I+II} - S^2{}_I - S^2{}_{II}]/2}{S_I\ S_{II}}$$

also $A_{I+II} = A_I + A_{II}$

so $$r_{I,\ II} = \frac{C_{(I+II)} - C_I - C_{II}}{S_I\ S_{II}}$$

b) $$r_{I,\ (I+II)} = \frac{C_{I,\ (I+II)}}{S_I\ S_{(I+II)}}$$

where $C_{I,\ (I+II)} = \frac{1}{N}\ \Sigma\ (I - \bar{I})\ [I+II) - (\overline{I+II})]$

$$= \frac{1}{N}\ \Sigma\ (I - \bar{I})\ [(I-\bar{I})\ (II-\overline{II})]$$

$$= S^2{}_I + C_{I,II}$$

so $$r_{I,(I+II)} = \frac{S^2{}_I + C_{I,\ II}}{S_I\ S_{(I+II)}}$$

Program Listing:

```
     *LBLE       21 15
         1          01
      STOE       35 15
004      0          00
005   STOA       35 11
006   STOC       35 13
007   STOD       35 14
008   STO0       35 00
009    RTN          24
010  *LBLA       21 11
011      1          01
012   ST+0    35-55 00
013   RCL0       36 00
014   STOI       35 46
015     R↓         -31
016     R↓         -31
017   STOi       35 45
018     X²          53
019   RCLA       36 11
020      +         -55
021   STOA       35 11
022    RTN          24
023  *LBLD       21 14
024   RCLE       36 15
025   RCLD       36 14
026      -         -45
027      1          01
028      -         -45
029   X=0?       16-43
030   GSBC       23 13
031   RCLD       36 14
032      1          01
033      +         -55
034   STOD       35 14
035    RTN          24
036  *LBLC       21 13
037   RCLE       36 15
038      1          01
039      +         -55
040   STOE       35 15
041      0          00
042   STOD       35 14
043    RTN          24
044  *LBLB       21 12
045   STOB       35 12
046   GSBD       23 14
047   RCLD       36 14
048   STOI       35 46
049   RCLB       36 12
050   RCLi       36 45
051      X         -35
052   RCLE       36 15
0     STOi       35 45
```

```
065      2          02
066      X         -35
067      X         -35
068      ÷         -24
069      1          01
070    X⇄Y         -41
071      -         -45
072   RCLE       36 15
073   RCLE       36 15
074      1          01
075      -         -45
076      ÷         -24
077      X         -35
078    RTN          24
079  *LBLb    21 16 12
080      0          00
081    P⇄S       16-51
082   STO9       35 09
083    P⇄S       16-51
084   STOI       35 46
085  *LBL1       21 01
086    R/S          51
087   ISZI    16 26 46
088   RCLi       36 45
089      X         -35
090   GSB2       23 02
091   GTO1       22 01
092  *LBLc    21 16 13
093    P⇄S       16-51
094   RCL9       36 09
095    P⇄S       16-51
096   RCLA       36 11
097   RCLC       36 13
098      2          02
099      X         -35
100      +         -55
101     √X          54
102      ÷         -24
103    RTN          24
104  *LBL2       21 02
105    P⇄S       16-51
106   ST+9    35-55 09
107    P⇄S       16-51
108    RTN          24
109  *LBLd    21 16 14
1                   00
1                35 46
1                22 02
```

```
123      2          02
124      -         -45
125   STOI       35 46
126     R↓         -31
127   STOi       35 45
128    CLX         -51
129   GTO3       22 03
130  *LBLe    21 16 15
131   RCL1       36 01
132   RCL4       36 04
133      2          02
134      X         -35
135      +         -55
136   STO7       35
137   RCL2       36
138   RCL5       36
139      2
140      X
141      +
142   STO8       35
143   RCL6       36 06
144   RCL4       36 04
145      -         -45
146   RCL5       36 05
147      -         -45
148   STO9       35 09
149   RCL7       36 07
150   RCL8       36 08
151      X         -35
152     √X          54
153      ÷         -24
154   PRTX         -14
155   RCL7       36 07
156   RCL9       36 09
157      +         -55
158   RCL9       36 09
159      2          02
160      X         -35
161   RCL7       36 07
162      +         -55
163   RCL8       36 08
164      +         -55
165   RCL7       36 07
166      X         -35
167     √X          54
168      ÷         -24
169    PRT         -14
170                 24
171                 51
```

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# Regression Differences

## Program Summary

This program performs a series of tests developed by Gulliksen and Wilks (1950) on data drawn from K samples to determine what differences, if any, exist among the samples. The hypotheses tested are:

a) $H_A$ - the standard errors of estimate among the samples are equal,

b) $H_B$ - all regression lines are parallel,

c) $H_C$ - the regression lines are identical (i.e., have equal intercepts), and

d) $H_S$ - a global hypothesis that the samples are equal in all three ways.

When conducting these tests, one may wish to first examine the global test ($G_S$). If $G_S$ is not significant, then there are no differences among the samples and therefore it is not necessary to evaluate the individual hypotheses. However, if the individual tests are evaluated, they should be examined sequentially because the test of $H_B$ assumes that the test of $H_A$ was nonsignificant, and the test of $H_C$ assumes that the tests for both $H_A$ and $H_B$ were nonsignificant.

Hypotheses $H_A$, $H_B$, $H_C$, and $H_S$ are evaluated by computing $G_A$, $G_B$, $G_C$, and $G_S$, respectively. These values are computed from the following data from each group: the number of people (n), the predictor mean and standard deviation, the criterion mean and standard deviation, and the correlation between the predictor and criterion.

## Instructions for Running Program

### Program limits:

Equations with only one predictor variable can be evaluated.

### Data preparation:

Standard deviations are assumed to be sample estimates of the population parameter: i.e.,

$$S = [(x-\bar{x})^2 / (N-1)]^{1/2}.$$

Set up the data to be analyzed in the following manner:

|  | Group |  |  |  |  |
|---|---|---|---|---|---|
|  | 1 | 2 | 3 | . . . | K |
| No. of people | $n_1$ | $n_2$ |  |  | $n_k$ |
| Correlation | $r_{x_1y_1}$ | $r_{x_2y_2}$ |  |  | $r_{x_ky_k}$ |
| Predictor Means | $\bar{x}_1$ | $\bar{x}_2$ |  |  | $\bar{x}_k$ |
| Criterion Mean | $\bar{y}_1$ | $\bar{y}_2$ |  |  | $\bar{y}_k$ |
| Predictor S | $S_{x_1}$ | $S_{x_2}$ |  |  | $S_{x_k}$ |
| Criterion S | $S_{y_1}$ | $S_{y_2}$ |  |  | $S_{y_k}$ |

Program execution:

Step

1 Enter program.

2 Press E.

3 Press A
enter $n_k$, press ↑
enter $r_{x_ky_k}$, press R/S
enter $\bar{x}_k$, press ↑
enter $\bar{y}_k$, press R/S
enter $S_{x_k}$, press ↑
enter $S_{y_k}$, press R/S.

* Perform the above sequence (Step 3) for groups 1 to K. Be sure to initiate sequence by pressing A.

4 After the data for each group has been entered, press B and the following values will be printed: $G_S$, $G_A$, $G_B$, and $G_C$, respectively. These are used to test $H_S$, $H_A$, $H_B$, and $H_C$, respectively. $G_S$, $G_A$, $G_B$, and $G_C$ are approximately distributed according to a chi-square distribution with the following degrees of freedom:

| Coefficient | Degrees of Freedom |
|---|---|
| $G_S$ | 3 (K-1) |
| $G_A$ | K-1 |
| $G_B$ | K-1 |
| $G_C$ | K-1 |

where K = the number of groups.

Step

5 If small sample F-ratios for $H_B$ and $H_C$ are desired, enter K and press C.

Then $F_B$ and $F_C$ will be printed. $F_B$ is the F-ratio with K-1 and N-2K degrees of freedom for homogeneity of slopes. $F_C$ is the F-ratio with K-1 and N-K-1 degrees of freedom for the equality of intercepts. (Note: $N = \Sigma n_k$.)

Test Data

| | Group 1 | Group 2 |
|---|---|---|
| n | 10 | 12 |
| $r_{xy}$ | .965 | .973 |
| $\bar{x}$ | 5.500 | 15.917 |
| $\bar{y}$ | 5.400 | 5.083 |
| $S_x$ | 3.028 | 8.339 |
| $S_y$ | 4.222 | 2.938 |

Program results:

$G_S$ = 54.14
$G_A$ = 2.50
$G_B$ = 38.11
$G_C$ = 13.53
$F_B$*= 83.77
$F_C$ = 16.14

*$F_B$ is the same as $F_{HM}$ printed out in the "Differences between Slopes and Correlations" program (see pg. 43).

Formulae

The procedures used are based upon those described by Gulliksen and Wilks (1950), however, the following computational formuli were used in this program:

$$S_k = (n_k-1)\ S_{y_k}^{\ 2}\ (1-r_{x_k y_k}^{\ 2})$$

$$S = \sum_k [(n_k-1)\ S_{y_k}^{\ 2}] - \sum_k [(n_k-1)\ (r_{x_k y_k}\ S_{x_k}\ S_{y_k})]^2 / \sum_k (n_k-1)\ S_{x_k}^{\ 2}$$

$$\bar{S} = \sum_k (n_k-1)\ S_{y_k}^{\ 2} + \sum_k n_k\ \bar{y}_{k.}^{\ 2} - N\bar{y}_{..}^{\ 2} - \{[\sum_k (n_k-1)\ (r_{x_k y_k} S_{x_k} S_{y_k}) + \sum_k$$
$$(n_k\ \bar{x}_{k.}\ \bar{y}_{k.}) - N\ \bar{x}_{..}\ \bar{y}_{..}]^2 / \Sigma\ [(n_k-1)\ S_{x_k}^{\ 2}] + \Sigma\ n_k\ \bar{x}_{k.}^{\ 2} - N\ \bar{x}_{..}^{\ 2}\}$$

Program Listing:

```
001
002  CLRG    16-53
003     2       02
004  STOA    35 11
005  STOB    35 12
006  STOC    35 13
007   RTN       24
008 *LBLA    21 11
009   R/S       51
010  STOE    35 15
011    R↓      -31
012  STOD    35 14
013  RCLA    36 11
014     +      -55
015  STOA    35 11
016  RCLD    36 14
017     1       01
018     -      -45
019  STOI    35 46
020   CLX      -51
021   R/S       51
022  STOB    35 12
023  ENT↑      -21
024    X²       53
025  RCLD    36 14
026     x
027  ST+8  35-
028    R↓
029  RCLD    36
030     x      -35
031  ST+7 35-55 07
032    R↓      -31
033    X²       53
034  RCLD    36 14
035     x      -35
036  ST+6 35-55 06
037    R↓      -31
038  RCLD    36 14
039     x      -35
040  ST+5 35-55 05
041  RCLB    36 12
042     x      -35
043  ST+9 35-55 09
044   CLX      -51
045   R/S       51
046  STOC    35 13
047    R↓      -31
048  STOB    35 12
049    X²       53
050  RCLI    36 46
051     x      -35
052  ST+2  35
053  RCLC
054    X²
055  RCLI
056     x
057
058             ..
059          36 13
060             53
```

```
061            -45
062            -35
063
064            -4
065            -24
066            -32
067          36 14
068            -35
069         -55 01
070  RCLI    36 46
071  RCLE    36 15
072     x      -35
073  RCLB    36 12
074     x      -35
075  RCLC    36 13
076     x      -35
077  ST+4 35-55 04
078   CLX      -51
079   RTN       24
080 *LBLB    21 12
081  RCL3    36 03
082  RCL4    36 04
083    X²       53
084  RCL2    36 02
085     ÷
086     -
087  STOE    3
088  RCL3    3
089  RCLA    36
090     ÷      -24
091  STO5    35 05
092    X²       53
093  RCLA    36 11
094     x      -35
095  STOI    35 46
096  RCL7    36 07
097  RCLA    36 11
098     ÷      -24
099  STO7    35 07
100  RCL3    36 03
101  RCL8    36 08
102     +      -55
103  RCL7    36 07
104    X²       53
105  RCLA    36 11
106     x      -35
107     -      -45
108  RCL4    36 04
109  RCL5    36 05
110     +      -55
111  RCLA       11
112  RCL       35
113            -35
114
115            -35
116            -2
117
118             02
119             01
120            -35
```

```
121          35
122             -
123
124     -      -45
125  STOI    35 46
126  RCLA    36
127     ÷      -24
128    LN       32
129  STOD    35 14
130  RCL8    36 08
131  RCLA    36 11
132     ÷      -24
133    LN       32
134  STOB    35 12
135  RCLE    36 15
136  RCLA    36 11
137     ÷      -24
138    LN       32
139  STOC    35 13
140  RCLD    36 14
141  RCLA    36
142     x
143  RCL1    36
144     -      -4
145  PRTX      -14
146  RCLB    36 12
147  RCLA    36 11
148     x      -35
149  RCL1    36 01
150     -      -45
151  PRTX      -14
152  RCLC    36 13
153  RCLB    36 12
154     -      -45
155  RCLA    36 11
156     x      -35
157  PRTX      -14
158  RCLD    36 14
159  RCLC    36 13
160     -      -45
161  RCLA    36 11
162     x      -35
163  PRTX      -14
164   RTN       24
165 *LBLC    21 13
166  STO1    35 01
167  RCLA    36 11
168     2       02
169          36 01
170     x      -35
171     -      -45
172  RCLE    36 15
173  RCL8    36 08
174     -      -45
175     x      -35
176  RCL1    36 01
177             01
178            -45
179          36 01
180            -35
```

```
181            -24
182            -14
183          36 11
184  RCL1    36 01
185     -      -45
186     1       01
187     -      -45
188  RCLI    36 46
189  RCLE    36 15
190     -      -45
191     x      -35
192  RCL1    36 01
193     1       01
194     -      -45
195  RCLE    36 15
196     x      -35
197     ÷      -24
198  PRTX      -14
199   RTN       24
200   R/S       51
```

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## Differences between Slopes and between Correlations

### Program Summary

This program consists of a series of tests between regression slopes and correlations. These tests include:

a) the test between correlations from independent samples (McNemar, 1969; p. 157-158),

b) the difference between correlated correlations, i.e., correlations that are not from independent samples (McNemar, 1969, p. 158),

c) the test between the correlation of one pair of variables verses another pair of variables, i.e., $r_{14}-r_{23}$ (Kenny, 1975),

d) the test for homogenity of slopes (Gulliksen and Wilks, 1950; Winer, 1962, p. 587). (In addition, the hypothesis that the pooled regression slope not different from zero is tested.)

### Instructions for Running Program

Data preparation:

1. To compute the test between the correlation of one pair of variables versus another pair, lower triangle of the correlation matrix must be entered by column. Notice, this test computes the Z-value between $r_{14}$ and $r_{23}$. Therefore, if one had measures of a and b at time two (i.e., $a_2$ and $b_2$) and wished to know if the correlation between $a_2$ and $b_2$ was greater than the correlation between $a_1$ and $b_1$ (i.e., if size of the correlation was increasing over time), then one would set up the input as follows:

$$\begin{array}{cccccc} & & a_2 & a_1 & b_1 & b_2 \\ & a_2 & & & & \\ \leftarrow \text{contrast} \rightarrow & a_1 & r_{21} & & & \\ & b_1 & r_{31} & r_{32} & & \\ & b_2 & r_{41} & r_{42} & r_{43} & \end{array}$$

(The above would be a test of stationarity in a cross-lagged panel design.) Or, if one wished to determine whether the correlation of $a_1$ and $b_2$ was greater than $b_1$ and $a_2$ then the input would be set up as follows:

$$\begin{array}{cc|cccc}
 & & a_1 & a_2 & b_1 & b_2 \\
\hline
 & a_1 & & & & \\
\leftarrow \text{contrast} \rightarrow & a_2 & r_{21} & & & \\
 & b_1 & r_{31} & r_{32} & & \\
 & b_2 & r_{41} & r_{42} & r_{43} &
\end{array}$$

(The above would be a test of spuriousness in a cross-lagged panel design, however, $r_{41}$ and $r_{32}$ should be corrected for changes in reliability [see Kenny, 1975, p. 897].)

2. If the desired test is the F-ratio for the homogenity of slopes, then set up the group data as follows:

| | Group | | | |
|---|---|---|---|---|
| | 1 | 2 | . . . | K |
| No. of people | $n_1$ | $n_2$ | $n_k$ | |
| Correlation | $r_{x_1y_1}$ | $r_{x_2y_2}$ | $r_{x_ky_k}$ | |
| Predictor S | $S_{x_1}$ | $S_{x_2}$ | $S_{x_k}$ | |
| Criterion S | $S_{y_1}$ | $S_{y_2}$ | $S_{y_k}$ | |

Program execution:

Case A: the test between correlations from independent samples.

Step

1 Enter $r_{x_1y_1}$, press ↑

Enter $n_1$, press ↑

Enter $r_{x_2y_2}$, press ↑

Enter $n_2$, press A.

* The Z for the difference between $r_{x_1y_1}$ and $r_{x_2y_2}$ is printed.

Case B: the test between correlated correlations.

Step

1 Enter n, press ↑
Enter $r_{12}$, press ↑

Enter $r_{13}$, press ↑

Enter $r_{23}$, press B.

Step

* The *t*-value with N-3 degrees of freedom is printed for the difference between $r_{12}$ and $r_{13}$.

Case C: the test between the correlation of one pair of variables versus another pair.

Step

1 Enter n, press ↑
Enter $r_{12}$, press ↑
Enter $r_{13}$, press ↑
Enter $r_{14}$, press C.

2 Enter $r_{23}$, press ↑
Enter $r_{24}$, press ↑
Enter $r_{34}$, press R/S.

* The Z value for the difference between $r_{14}$ and $r_{23}$.

Case D: the test for homogenity of slopes.

Step

1 Press f cl reg (clear register).

2 Enter $n_k$, press ↑
Enter $r_{x_k y_k}$, press ↑
Enter $S_{x_k}$, press ↑
Enter $S_{y_k}$, press D.

* Perform Step 2 for groups 1 to k.

3 After the data for all the groups has been entered, press R/S.

* Then $B_W$, $F_{s1}$, and $F_{hm}$ are printed. $B_W$ is the magnitude of the pooled regression slope. To determine the sign of $B_W$, recall register 7 (RCL 7). If the value in register 7 is negative then $B_W$ is negative.

$F_{s1}$ tests whether $B_W$ is significantly different from zero.

$F_{hm}$ is the test for the homogenity of slope.

$F_{s1}$ has 1 and N-K-1 degrees of freedom, and
$F_{hm}$ has K-1 and N-2K degrees of freedom.

## Test Data

Case A:

| | Group | |
|---|---|---|
| | 1 | 2 |
| $r_{xy}$ | .34 | .47 |
| n | 40 | 25 |

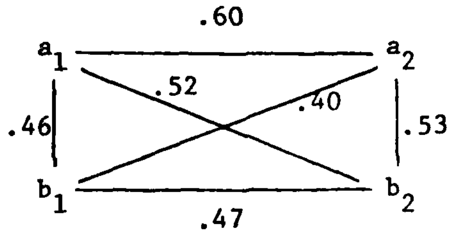
Case B:

| | | Variable Correlations | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | 1 | 1.00 | | |
| Variable | 2 | .609 | 1.00 | |
| | 3 | .344 | .517 | 1.00 |

No. of people (N) = 500.

Case C:

Let the following be the pattern of correlations for 1501 people between two assessments (a and b), each being measured at two times (1 and 2):



Then to determine if $r_{a_2 b_2}$ is significantly greater than $r_{a_1 b_1}$ (i.e., is .53 significantly larger than .46), set up the data as follows:

| | $a_2$ | $a_1$ | $b_1$ | $b_2$ |
|---|---|---|---|---|
| $a_2$ | \| | | | |
| $a_1$ | .60 | \| | | |
| $b_1$ | .40 | .46 | \| | |
| $b_2$ | .53 | .52 | .47 | \| |

And, to determine if there is a significant difference between the cross-lagged correlations (i.e., between .52 and .40), set up the data as follows:

| | $a_1$ | $b_1$ | $a_2$ | $b_2$ |
|---|---|---|---|---|
| $a_1$ | \| | | | |
| $b_1$ | .46 | \| | | |
| $a_2$ | .60 | .40 | \| | |
| $b_2$ | .52 | .47 | .53 | \| |

Note: Kenny (1975, p. 897) recommends that the cross-lagged correlations be adjusted for changes in reliability before testing for the difference between them. No correction was used in this example, however.

Case D:

| | Group | |
|---|---|---|
| | 1 | 2 |
| n | 10 | 12 |
| $r_{xy}$ | .965 | .973 |
| Sx | 3.028 | 8.339 |
| Sy | 4.222 | 2.938 |

Program results:

Case A:

$Z = -.5794$

Case B:

$t = 7.5852$

Case C:

$Z_1 = 2.8819$

$Z_2 = 4.8041$

Case D:

$|B_W| = .4404$*

$F_{SL} = 34.3325$

$F_{HM} = 83.7702$**

*Contents of register 7 = 373.2542 = positive, thus $B_W$ is positive.

**$F_{HM}$ is the same as $F_B$ in the "Regression Differences" program (see pg. 36).

Formulae

Case A:

$$Z_r = 1/2 \log_e \frac{1+r}{(1-r)}$$

$$Z \text{ diff} = (Z_{r_{x_1y_1}} - Z_{r_{x_2y_2}}) \; / \; \{[1/(n_1-3)] + [1/(n_2-3)]\}$$

Case B:

$$t + \{(r_{12}-r_{13})[(N-3)(1-r_{23})]^{1/2}\}/[2(1-r^2_{12}-r^2_{13}-r^2_{23}+2r_{12}r_{13}r_{23})]^{1/2}$$

df - N-3

Case C: (cf. Kenny, 1974)

$$Z = [N^{1/2}(r_{14}-r_{23})]/[(1-r^2_{14})^2 + (1-r^2_{23})^2-K]^{1/2}$$

where,

$$K = (r_{12}-r_{24}r_{14})(r_{34}-r_{24}r_{23})$$

$$+ (r_{13}-r_{12}r_{23})(r_{24}-r_{12}r_{14})$$

$$+ (r_{12}-r_{13}r_{23})(r_{34}-r_{13}r_{14})$$

$$+ (r_{13}-r_{14}r_{34})(r_{24}-r_{34}r_{23})$$

Case D:

a) $|B_W| = [(R^2_W \; S^2_{YW})/S^2_{XW}]^{1/2}$

where,

$$R^2_W = C^2_W/(S^2_{XW} \; S^2_{YW})$$

and $C^2_W = \{\sum_k [C_k(n_k-1)]\}^2$

where $C_k = r_{x_k y_k} \; S_{x_k} \; S_{y_k}$

$$S^2_{XW} = \sum_k [S^2_{x_k} \; (n_k-1)]$$

$$S^2_{YW} = \sum_k [S^2_{y_k} \; (n_k-1)]$$

b) $F_{s1} = \{R_W{}^2[(\sum_k(n_k-1))-1]\}/(1-R^2_W)$

df = 1 and N-G-1

c) $F_{hm} = [\sum_k[r_{x_k y_k}{}^2 \; S_{y_k}{}^2(n_k-1)]-\{\sum[S_{y_k}{}^2(n_k-1)]\}R_W{}^2]\{[\sum_k(n_k-1)]-K\}/$

$[\{\sum[S_{y_k}{}^2(n_k-1)] - \sum[r_{x_k y_k}{}^2 S_{y_k}{}^2(n_k-1)]\}(k-1)]$

df = K-1 and N-2K

Program Listing:

```
[illegible]  [illegible]   36 0[illegible]
00[illegible]  [illegible]   35 04
00[illegible]  R↓            -31
004  STO3        35 03
005  R↓            -31
006  STO2        35 02
007  R↓            -31
008  STO1        35 01
009  RTN            24
010  *LBL0       21 00
011  1              01
012  RCL2        36 02
013  +             -55
014  1              01
015  RCL2        36 02
016  -             -45
017  ÷             -24
018  LN             32
019  2              02
020  ÷             -24
021  RTN            24
022  *LBL2       21 02
[illegible]  x             -35
[illegible]  -             [illegible]
[illegible]  RTN           [illegible]
[illegible]  *LBL3       [illegible]
027  GSB2        2[illegible]
028  x             [illegible]
029  ST+8     35-55 [illegible]
030  RTN           [illegible]
031  *LBLA       21 11
032  GSB1        23 01
033  STO6        35 06
034  GSB0        23 00
035  STO5        35 05
036  RCL3        36 03
037  STO6        35 06
038  GSB0        23 00
039  ST-5     35-45 05
040  3              03
041  ST-2     35-45 02
042  ST-4     35-45 04
043  RCL5        36 05
044  RCL2        36 02
045  1/x            52
046  RCL4        36 04
047  1/x            52
048  +             -55
049  √X             54
050  ÷             -24
051  PRTX          -14
052  RTN            24
053  *LBLB       21 12
054  GSB1        23 01
055  3              03
056  -             -45
0[illegible]  .         [illegible]
0[illegible]             36 04
0[illegible]               -35
0[illegible]               -35

[illegible]                [illegible]
062               [illegible]
063  RCL[illegible]       [illegible]
064  -             -45
065  x             -35
066  1              01
067  RCL2        36 02
068  X²             53
069  -             -45
070  RCL3        36 03
071  X²             53
072  -             -45
073  RCL4        36 04
074  X²             53
075  -             -45
076  2              02
077  RCL2        36 02
078  x             -35
079  RCL3        36 03
080  x             -35
081  RCL4        36 04
082  x             -35
083  +             -55
084  2              02
085  x             -35
086  √X             54
087  ÷
088  PRTX
089  RTN
090  *LBLC
091  GSB1        23 01
092  R/S            51
093  STO7        35 07
094  R↓            -31
095  STO6        35 06
096  R↓            -31
097  STO5        35 05
098  0              00
099  STO8        35 08
100  RCL2        36 02
101  RCL6        36 06
102  RCL4        36 04
103  GSB2        23 02
104  RCL7        36 07
105  RCL6        36 06
106  RCL5        36 05
107  GSB3        23 03
108  RCL3        36 03
109  RCL[illegible]       36 02
110  [illegible]        [illegible]
111  [illegible]        [illegible]
112  RCL[illegible]       36 0[illegible]
113  RCL[illegible]       36 0[illegible]
114  RCL4        36 04
115  GSB3        23 03
116  RCL[illegible]       36 02
                  36 03
                  36 05
                  23 02
                  36 07

[illegible]                36 03
122              36 04
123              23 03
124  RCL[illegible]       36 0[illegible]
125  RCL4        36 04
126  RCL7        36 07
127  GSB2        23 02
128  RCL6        36 06
129  RCL7        36 07
130  RCL5        36 05
131  GSB3        23 03
132  RCL1        36 01
133  √X             54
134  RCL4        36 04
135  RCL5        36 05
136  -             -45
137  x             -35
138  1              01
139  RCL4        36 04
140  X²             53
141  -             -45
142  X²             53
143  1
144  RCL5
145  X²
146  -
147  X²             53
148  +             -55
149  RCL6        36 06
150  -             -45
151  √X             54
152  ÷             -24
153  PRTX          -14
154  RTN            24
155  *LBLD       21 14
156  GSB1        23 01
157  1              01
158  ST-1     35-45 01
159  ST+0     35-55 00
160  RCL3        36 03
161  X²             53
162  RCL1        36 01
163  ST+8     35-55 08
164  x             -35
165  ST+5     35-55 05
166  RCL4        36 04
167  X²             53
168  RCL1        36 01
169  x             -35
170  ST+6     35-55 06
171  RCL2        36 02
172  X²             53
173                -35
174  ST+9     35-55 09
175  RCL2        36 02
176  RCL3        36 03
17[illegible]               -35
17[illegible]            36 04
17[illegible]               -35
18[illegible]            36 01

181
182
183
184  RCL7        [illegible]
185  X²             [illegible]
186  RCL5        [illegible]
187  ÷             [illegible]
188  RCL6        [illegible]
189  ÷             -2[illegible]
190  STOA        35 11
191  RCL5        36 05
192  x             -35
193  RCL5        36 05
194  ÷             -24
195  √X             54
196  PRTX          -14
197  RCLA        36 11
198  RCL8        36 08
199  1              [illegible]
200  -
201  x
202  1
203  RCLA        36
204  -             -45
205  ÷             -24
206  PRTX          -14
207  RCL9        36 09
208  RCL6        36 06
209  RCLA        36 11
210  x             -35
211  -             -45
212  RCL0        36 00
213  1              01
214  -             -45
215  ÷             -24
216  RCL6        36 06
217  RCL9        36 09
218  -             -45
219  RCL8        36 08
220  RCL0        36 00
221  -             -45
222  ÷             -24
223  ÷             -24
224  PRTX          -14
```

# Difference Between Multiple Correlations

## Program Summary

This program computes the difference between two multiple correlations which are computed on the same sample of people and the variables in one regression equation are a subset of the variables in the other equation. The test used was described by Summerfield and Lubin (1951) and Cohen (1968). A useful application of this program can be made by performing a multiple regression analyses in the manner described by Cohen (1968), Darlington (1968), Gocka (1973), and Overall and Spiegel (1969), and converting the results into an ANOVA design with this HP-97 program.

## Instructions for Running Program

### Program limits:

A maximum of eight squared multiple correlations can be input in one pass.

### Data preparation:

Set up the input data in the following manner:

| Variable Set | $R^2$ | df |
|---|---|---|
| A | $R^2_a$ | $df_a$ |
| B | $R^2_b$ | $df_b$ |
| C | $R^2_c$ | $df_c$ |
| . | . | . |
| . | . | . |
| . | . | . |
| L | $R^2_L$ | $df_L$ |
| | | $df_{L+1}$ |

Notice:

1) The maximum number of variable sets ($R^2$ values) is eight.

2) The program uses the squared multiple correlation ($R^2$).

3) The degrees of freedom for a variable set is equal to the number of unique variables in the set. That is, the number of variables in the set minus those used in previous sets. Or, $df_i = P_i - P_{i-1}$.

   Where $P_i$ = the number of variables in the $i^{th}$ set and $P_{i-1}$ = the number of variables in the prior set.

4) There is one more df value than there are $R^2$ values. The last df value is the degrees of freedom for the residual and is equal to the total number of people minus the total number of different variables minus one, i.e., $df_{L+1} = N-P_L-1$

where N = the number of people and $P_L$ = the number of predictors in the last variable set.

Program execution:

Step

1 Enter program.

2 Press E.

3 Enter each df value *pressing A* after each one (i.e., enter $df_a$, press A; enter $df_b$, press A; etc.).

4 Press E.

5 Enter each $R^2$ *pressing A* after each one (i.e., enter $R^2{}_a$, press A; enter $R^2{}_b$, press A; etc.).

6 Press B and the *F*-ratio for each variable set will be printed. Note, each *F* indicates whether the amount of variance accounted for at a particular level is significantly more than the amounts previously accounted for.

Test Data

| Variable Set | $R^2$ | df |
|---|---|---|
| A | .1000 | 2 |
| B | .2000 | 3 |
| AXB | .3000 | 6 |
| Residual | | 88 |

The above data represents the regression output for a two-way ANOVA with three levels of A, four levels of B and 100 people.

Program results:

| Variable Set | F-Ratio |
|---|---|
| A | 6.29 |
| B | 4.19 |
| AXB | 2.10 |

Formulae

$$F = \frac{(R^2_i - R^2_{i-1}) / (df_i - df_{i-1})}{(1 - R^2_L / (df_{L+1})}$$

where $R^2_i$ is the $R^2$ for the $i^{th}$ set of variables

$R^2_{i-1}$ is the $R^2$ for the prior set of variables, when $i=1$, $R^2_{i-1} = 0$.

$df_i$ is the number of variables in the $i^{th}$ set of variables not found in prior variable sets.

$df_{i-1}$ is the number of variables data set prior to the $i^{th}$ set which were not found in earlier variable sets.

$R^2_L$ is the $R^2$ using all predictor variables.

$df_{L+1}$ is the degrees of freedom for the residual, i.e., $df_{L+1} = N-P_L-1$.

where N is the total number of people, and $P_L$ is the total number of predictors (i.e., the number of variables in the last data set).

Program Listing:

```
[illegible]                        15
0[illegible]                       32
003   STO8        35 08
004   STOI        35 46
005    P⇄S        16-51
006    RTN           24
007  *LBLA        21 11
008   ISZI     16 26 46
009   STOi        35 45
010   RCLI        36 46
011    RTN           24
012  *LBLB        21 12
013      1           01
014   RCLi        36 45
015      -          -45
016   STOE        35 15
017   RCLI        36 46
018      1           01
019      +          -55
020   STOI        35 46
021    P⇄S        16-51
022   [illegible]
023   RCLi        36 45
024      ÷          -24
025   STOE        35 15
026    P⇄S        16-51
027   RCLI        36 46
028      1           01
029      -          -45
030   STOD        35 14
031      0           00
032   STOI        35 46
033  *LBL1        21 01
034   ISZI     16 26 46
035   RCLi        36 45
036   RCLI        36 46
037      1           01
038      -          -45
039   STOI        35 46
040     R↓          -31
041   RCLi        36 45
042      -          -45
043   RCLI        36 46
044      1           01
045      +          -55
046   STOI        35 46
047     R↓          -31
048    P⇄S        16-51
049   RCLi        36 45
050    P⇄S        16-51
051      ÷          -24
052   RCLE        36 15
053      ÷          -24
054   FRC          -14
055   RCLD        36 14
056   RCLI        36 46
057   X=Y?        16-33
058   GTO1        22 01
059   GTO[illegible]  22 [illegible]
060   [illegible]
061   [illegible]
```

# NON-STATISTICAL PROGRAMS

## Data Plotting

### Program Summary

This program uses the printing capability of the HP-97 calculator to construct a plot of 2 to 9 data points. Each data point is plotted from 1 to 10 units above the base, thus, there are nine increments from the smallest to largest value. The user has the option of automatic or fixed scaling. Under the automatic scaling procedure the smallest value is plotted 1 unit from the base and the largest is printed 10 units from the base. By interpolation, the remaining values are converted to the 1 to 10 scale. Under the fixed scaling procedure, the user chooses the scale end points. That is, the user selects which value shall be plotted 1 unit from the base and which value shall be printed 10 units from the base. And by interpolation, each value entered is converted from the preselected scale to a 1 to 10 scale.

### Instructions for Running Program

Program limits:

A maximum of 9 data points can be plotted in one pass.

Data preparation:

If fixed scaling is desired, peruse that data making sure no value to be plotted is smaller than the low end of the preselected scale and no greater than the high end of the preselected scale.

Program execution:

Step

1 Enter program.

2 Select scaling procedure.

* If fixed scaling is desired:

- enter the low value on the preselcted scale, press ↑
- enter the high value on the preselected scale, and press fa.

* If automatic scaling is desired, press fb.

3 Press E.

4 Enter data value to be plotted pressing A after each value.

5 After the data has been entered, press B and the plot will be printed.

* To enter a new data set and the same scaling procedure is desired [i.e., either a) the fixed scaling option had been selected and fixed scaling using the same preselected scale is desired, or, b) automatic scaling had been selected and is desired again so that the low value will be 1 unit above the base and the high value will be 10 units above the base] then go to Step 3.

Step

* If a new scaling procedure is desired, go to Step 2.

## Test Data

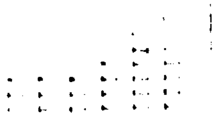
Data Points

7
11
20
33
55
90

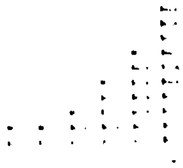
Preselected scale {0 to 125}

Program results:

a) Fixed Scaling:



b) Automatic Scaling:



## Program Listing:

```
[illegible]
008  STOB      35 12
009     0         00
010  STOA      35 11
011  *LBLd  21 16 14
012     0         00
013  STOI      35 46
014   RTN         24
015  *LBLA     21 11
016  ISZI   16 26 46
017  STOI      35 45
018   F0?   16 23 00
019  GTOc   22 16 13
020  ENT↑        -21
021  ENT↑        -21
022  RCLA      36 11
023  X≤Y?      16-35
024   X≠Y        -41
025  STOA      35 11
026    R↓        -31
027    R↓        -31
028  RCLB      36 12
029  X>Y?      16-34
030   X≠Y        -41
031  STOB      35 12
032  *LBLc  21 16 13
033   CLX        -51
034   RTN         24
035  *LBLB     21 12
036   F0?   16 23 00
037  GTOe   22 16 15
038  RCLA      36 11
039  RCLB      36 12
040     -        -45
041  STOA      35 11
042  *LBLe  21 16 15
043  RCLI      36 46
044     1         01
045     +        -55
046  STOI      35 46
047  *LBLD     21 14
048  DSZI   16 25 46
049  [illegible]  22 13
050   RTN         24
051  [illegible]  21 13
052  [illegible]  36 45
053  [illegible]  36 12
054     -        -45
055  [illegible]  35 11
[illegible]        -24
[illegible]

[illegible]
[illegible]        35 46
[illegible]
[illegible]        35 46
[illegible]
071  *LBL0     21 00
072     .        -62
073     1         01
074  PRTX        -14
075   RTN         24
076  *LBL1     21 01
077     .        -62
078     1         01
079     1         01
080  PRTX        -14
081   RTN         24
082  *LBL2     21 02
083     .        -62
084     1         01
085     1         01
086     1         01
087  PRTX        -14
088   RTN         24
089  *LBL3     21 03
090     .        -62
091     1         01
092     1         01
093     1         01
094     1         01
095  PRTX        -14
096   RTN         24
097  *LBL4     21 04
098     .        -62
099     1         01
100     1         01
101     1         01
102     1         01
103     1         01
104  PRTX        -14
105   RTN         24
106  *LBL5     21 05
107     .        -62
108     1         01
109     1         01
110     1         01
111     1         01
112     1         01
113     1         01
114  PRTX        -14
115   RTN         24
116  *LBL6     21 06
117              -62
[illegible]

[illegible]
123     .         
124     1         01
125  PRTX        -14
126   RTN         24
127  *LBL7     21 07
128     .        -62
129     1         01
130     1         01
131     1         01
132     1         01
133     1         01
134     1         01
135     1         01
136     1         01
137  PRTX        -14
138   RTN         24
139  *LBL8     21 08
140     .        -62
141     1         01
142     1         01
143     1         01
144     1         01
145     1         01
146     1         01
147     1         01
148     1         01
149     1         01
150  PRTX        -14
151   RTN         24
152  *LBL9     21 09
153     .        -62
154     1         01
155     1         01
156     1         01
157     1         01
158     1         01
159     1         01
160     1         01
161     1         01
162     1         01
163     1         01
164  PRTX        -14
165   RTN         24
166  *LBLa  21 16 11
167   X≠Y        -41
168     -        -45
169  STOA      35 11
170  LSTX      16-63
171  STOB      35 12
172   SF0   16 21 00
173   RTN         24
174  *LBLb  21 16 12
175   CF0   16 22 00
176   RTN         24
177   R/S         51
```

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# Sort

## Program Summary

This program will sort from 2 to 22 numbers in ascending order and then print them.

## Instructions for Running Program

### Program limits:

A maximum of 22 values can be sorted at one time. The number of seconds to sort a set of variables is equal to the square of the number of variables (i.e., $secs = v^2$).

### Data Preparation:

Suggestion: Information associated with the values to be sorted can be linked to the data points by adding it on after the last significant digit. For example, if a set of integers from an R by C matrix are to be sorted, a decimal point can be placed after the integer and then the row and column value can be added (i.e., I.rc).

### Program execution:

**Step**

1 Enter program.

2 Press E.

3 Enter each value to be sorted pressing A after each value.

4 After all the values have been entered, press B to initiate the sort process.

5 Press fa, to print the sorted values.

## Test Data

| | | Columns | |
|---|---|---|---|
| | | 1 | 2 |
| | 1 | 43 | 46 |
| Rows | 2 | 26 | 97 |
| | 3 | 81 | 14 |

Program results:

a) Sort of values within cells:

```
14
26
43
46
81
97
```

b) Sort of cell values with associated row and column indices:

```
14.32
26.21
43.11
46.12
81.31
97.22
```

Program Listing:

```
001  *LBLE      21 15
002   CLRG     16-53
003    P≷S     16-51
004   CLRG     16-53
005    CLX       -51
006    RTN        24
007  *LBLA      21 11
008   STOI      35 46
009   ISZI   16 26 46
010   RCLI      36 46
011   STOD      35 14
012    RTN        24
013  *LBLB      21 12
014      0        00
015   STOI      35 46
016  *LBL0      21 00
017   RCLI      36 46
018   STOE      35 15
019   GSBC      23 13
020   RCLE      36 15
021      1        01
022      +       -55
023   STOI      35 46
024   RCLD      36 14
025      1        01
026      -       -45
027      -       -45
028   X≠0?     16-42
029   GTO0      22 00
030   RCLD      36 14
031   STOI      35 46
032    RTN        24
```

```
038    X≷Y       -41
039   STOI      35 46
040     R↓       -31
041   RCLE      36 15
042    X≷I     16-41
043    X≷Y       -41
044   STOI      35 46
045     R↓       -31
046    X≷I     16-41
047   STOE      35 15
048   RCLI      36 46
049   RCLD      36 14
050      -       -45
051   X≠0?     16-42
052   GTOC      22 13
053    RTN        24
054  *LBLD      21 14
055   RCLI      36 46
056   RCLE      36 15
057    X≷I     16-41
058   STOE      35 15
059     R↓       -31
060    RTN        24
061  *LBLa   21 16 11
062   DSZI   16 25 46
063   GTO2      22 02
064   GTO3      22 03
065  *LBL2      21 02
066   RCLI      36 46
067   PRTX       -14
068   GTOa   22 16 11
069  *LBL3      21 03
070   RCLI      36 46
071   PRTX       -14
072    RTN        24
```

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Documentation for 11 programs for the Hewlett-Packard 97 Calculator is contained in this report. Nine programs are statistical routines which compute a variety of coefficients including, chi square, t-ratio, F-ratio, multiple correlations, and Cronbach's alpha. The two nonstatistical routines include a data plotting program and a sort program. These programs are not designed to use raw data as input. Instead, they are designed to receive data commonly printed out during data analysis on a large computer system. (Over)

Documentation of each program includes a description of the t performed, program limits, step-by-step instructions for prog test data and solutions, formulae, and a program listing. Al a list of all the statistical tests and coefficients computed and pages on which they appear.

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